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POWER

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What Metals Mean to Man

WHAT a step forward it was in the progress of the race when man learned to use metals.

He had produced marvels with nothing but stone and flint and sharpened shells for hammer and cutting tools. The discovery of the bronzes and the most easily reducible metals opened new possibilities for his arts and new avenues for the exercise of his ingenuity.

And with the discovery of iron and steel the possibilities were vastly extended.

It would be difficult to imagine what the civilized world would be like, what the condition of the race would be today, if steel and iron were not cheap and plentiful.

Much has been said and written of the effect of power in reducing the burden of humanity and in lightening the severity of human labor.

But without steel and iron this power would never have got beyond the primitive water mill and no machinery could have been made for it to drive.

One glance at the structures, the fixtures and utensils about you will start an impressive train of thought as to the essentialness of metals to our present mode of living.

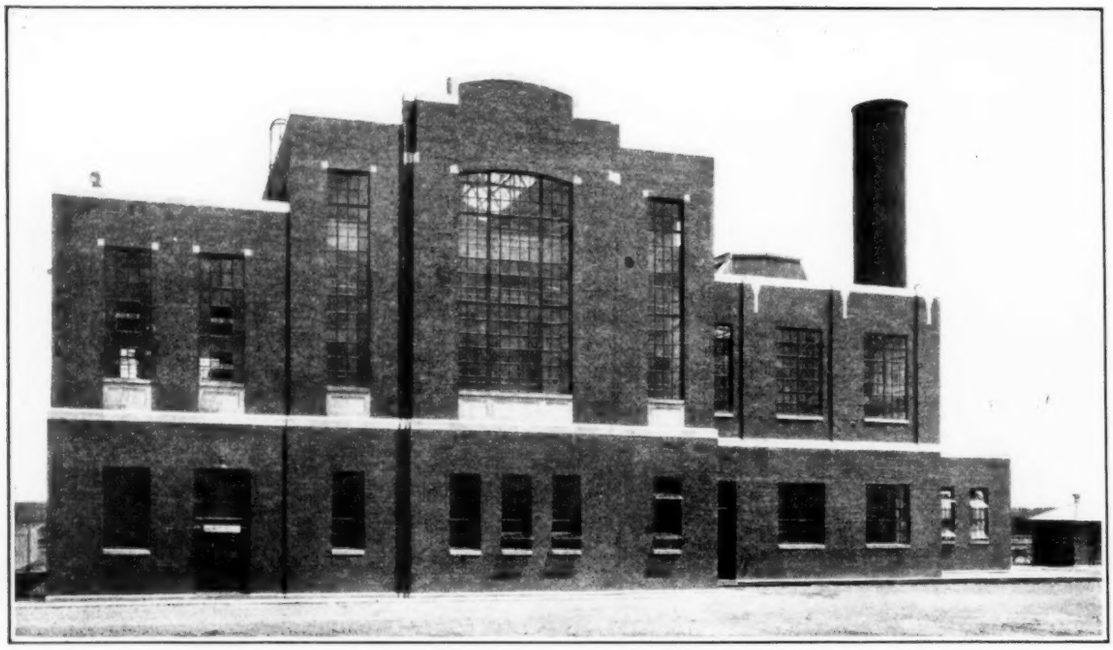
Many readers of *Power* will remember when aluminum was a novelty and nickel far from common, and have seen the nickel and chromium alloys that are filling so many useful purposes come in.

The rarer metals, aside from their ornamental and coinage uses, fill many useful purposes in the arts.

Industry is continually making more exacting demands. The power-plant engineer needs a cheap metal that will have a high tensile strength and ductility and not be impaired by high temperatures. He needs non-corrosive metals that will hold their surface under heavy sliding pressure, that will not suffer from abrasion or erosion under the impact of the swift steam or water jet.

The metallurgist has made possible many things, more things than is generally realized, in a big way. He will continue, as the industrial application of the result sof research requires, to provide the materials essential to further progress.

F. R. Low



Completed plant, Amarillo, Texas

Amarillo Plant Placed in Operation Seventy Days After Start of Construction

THE record made in the construction of the Amarillo plant, Texas, for the Southwestern Public Service Company is a notable one, and especially so when proper consideration is given to all the facts and conditions that prevailed to influence a hurried construction schedule.

There had been no rush in the design of the plant because the original schedule called for putting the unit in service on the first of June. Great care had been taken in selecting the best and latest type of mechanical and electrical equipment, and its arrangement had been thoroughly planned so as to produce the most efficient and durable plant possible. Equal consideration had been given to the selection of construction materials to be employed and also to the architectural beauty of the building itself. All arrangements had been made, contracts for the various materials and equipment had been let with delivery dates specified in accordance with this schedule, and construction work had been started, when conditions arose that resulted in the decision to complete the plant by the first of March, just three months in advance of the date originally planned. This decision was made Dec. 21, which allowed seventy days in which to complete the construction. The illustrations show the progress of the work.

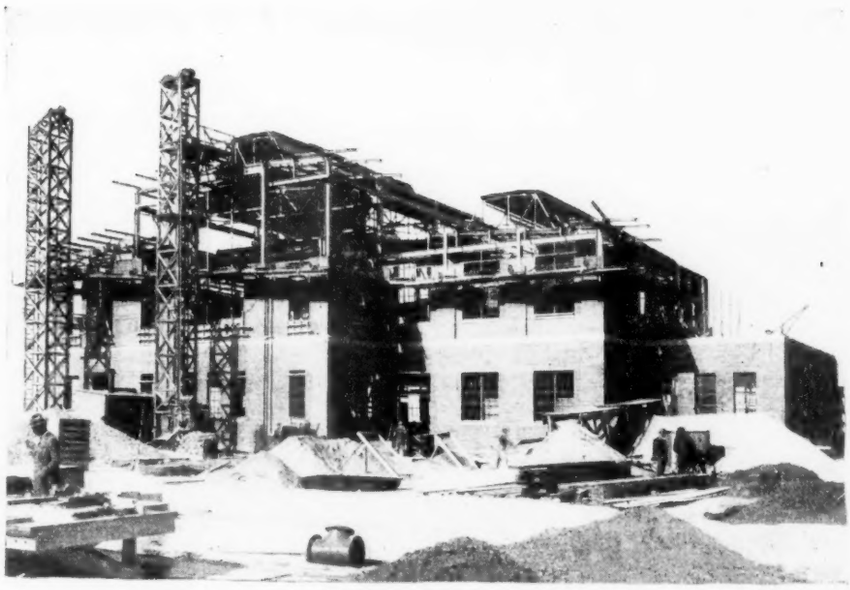
By H. S. McKNIGHT, *Construction Engineer Day & Zimmermann Engineering and Construction Co.*

Obviously, the influence of this decision, coming at this late date, extended beyond the immediate control of the designing and construction engineers. It became necessary to enlist the co-operation of all interested manufacturers, dealers and shippers of supplies and equipment, most of which material had to be moved practically across the entire continent. This co-operation was readily obtained, all delivery dates were advanced, and special rush orders were issued by the manufacturers to their shops to rush equipment to completion. The Engineers' Cost and Service Department kept a careful check on each item during its manufacture, shipment and delivery to the construction site.

Owing to the excellent quality of materials and equipment furnished, together with the efficient operations of the construction forces in the field, no serious obstacles were encountered and the job was successfully completed one day in advance of the new date specified.

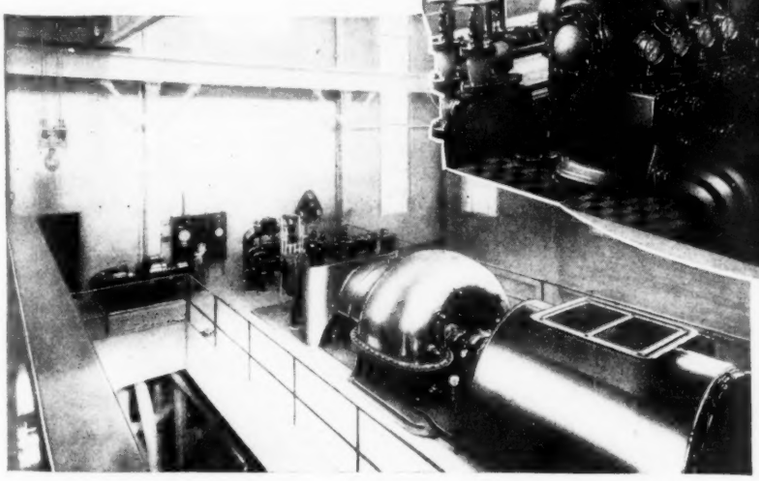
The plant was built to replace the inadequate plant of the Southwestern Public Service Company, which serves Amarillo and the surrounding territory with power

Below—The status of construction work at the Amarillo Plant when the time allotted for completion was shortened to seventy days



Above—After forty days of construction the power house looked like this. There remained only thirty days to finish the work on schedule time

Right—How the turbine room looked when the unit was placed in operation seventy days later



Left—The finished turbine room

and light. In its design provision was made for future extensions without in any way interfering with the operation of the initial unit and allowing for a future capacity of at least four times that of the present installation.

The site selected for its erection is a 25-acre tract one and a half miles east of the City of Amarillo, Texas, in a flat open country. It was necessary to make provision for permanent drainage and sewage disposal and also to construct pipe and power lines to provide water, gas and power from the city supply for construction purposes.

The building was constructed of concrete, steel and brick with tile and composition roof, and is fireproof throughout. Ample provision was made for lighting by means of large windows and also skylights in both the turbine and boiler rooms.

A permanent railroad siding enters the building on the south side next to the turbine foundation, thereby facilitating the handling of supplies and materials. This in turn is served by a 25-ton crane which operates above the railroad siding, turbine, and circulating pump well. The crane girders span the turbine room longitudinally, a distance of 47 feet.

In the east end of the building are the machine shop, toilet and lavatory, induced-draft fan room and boiler stack. The machine shop is completely equipped with machine tools and equipment sufficient to take care of all maintenance and minor repair work.

Boiler Equipment

The boilers are situated west of the induced draft fans and consist of two 8,360-sq.ft. inclined-tube units equipped with superheaters and designed to operate at 300 per cent rating with a steam working pressure of 300 lb. per sq.in. and 250 deg. of superheat. Necessary draft is furnished by motor-driven high-speed multivane induced-draft fans mounted on foundations at ground floor level, back of the boilers and directly under the stack. The stack is 9 ft. in diameter, extends 60 ft. above the roof and is supported by the building steelwork. The boilers are fired with natural gas, using Forney combination gas and oil burners. Air enters the burner compartments through dampered openings in the front and also through hollow-tile ducts which pass under and cool the floor of the furnace. The boilers are equipped with meters that record the flow of steam, air and flue gas and indicate the temperature in the furnace. Flow and temperature of feed water to the boilers and flow and temperature of steam to the main turbine are also recorded. The water is delivered to the boilers by centrifugal pumps of 300 g.p.m. capacity, one driven by a steam turbine and the other by a motor. The feed water entering the boilers is controlled by automatic regulators. The boilers are equipped with auxiliary oil-burning equipment to be used in case of an emergency.

The main turbine-generator unit is mounted on a reinforced concrete foundation at an elevation 20 ft. above the ground-floor level and is a 5,000-kw. three-phase 60-cycle 13,200-volt 3,600-r.p.m. turbine-generator with direct-connected exciter. An auxiliary turbine-driven exciter is also provided.

Mounted under the turbine on spring supports is an 8,500-sq.ft. two-pass surface condenser to which circulating water is delivered by two centrifugal circulating pumps of 5,000-g.p.m. capacity each at 1,160 r.p.m. One pump is driven through reducing gears by a steam turbine and the other by a direct-connected motor.

The ventilating air to the generator is purified and cooled by an air washer and cooler.

Air is removed from the condenser by a two-stage air ejector, and condenstate is removed by two centrifugal condensate pumps, each having a capacity of 125,000 lb. per hour. One pump is driven by a steam turbine and the other by a motor.

The condensate is delivered to a vertical open-type deaërating feed-water heater having a capacity of 80,000 lb. per hour. Bleeder steam from the main turbine and exhaust steam from the small turbines are used to heat the feed water.

Spray Pond for Circulating Water

Condenser circulating water is cooled and stored in a concrete spray pond just east of the main building. This spray pond is 90 ft. wide, 320 ft. long and 3 ft. 6 in. deep and is divided into two separate and equal compartments each having a capacity of 300,000 gal. Two main spray pipe lines extend the length of the pond, one over the center of each compartment, and are equipped with involute spray nozzles arranged in groups of five. The water to and from the spray pond is conducted through 20-in. cast-iron pipe lines, and makeup water is obtained from the city mains.

House service water is stored in a cylindrical tank under the roof in the boiler room. Water from the spray pond or city mains is elevated to this tank by means of turbine- and motor-driven pumps.

The west end of the building incloses the indoor electrical equipment, offices and battery room. A seventeen-panel switchboard is on the turbine floor just west of the generator unit, and between the switchboard and the west building wall is the bus and oil switch structure. This is a concrete cell structure supporting a double bus and mounting in individual cells the electrically operated oil switches. The potential and current transformers are mounted in cells on the west building wall, and the main feeder cables are taken from these compartments to the outside structures.

The outside bus and switching structures, transformers and lightning arresters are west of the building and provide for the necessary tie and distribution lines at both 44,000 and 13,200 volts.

In a Paper "Refractories in Power Plants," presented at a meeting of the American Refractories Institute, R. A. Sherman concludes that the present tendency toward the adoption of water-cooled walls for furnaces in those power plants in which the conditions of service exceed the inherent limitations of refractories should benefit rather than harm the refractories industry. The extent to which the water-cooled wall is being accepted is indicated by the 1927 Prime Movers Report, which shows that 70 per cent of the companies reporting are trying some type of water-cooled wall. In order to regain business in that field where it has been lost, the refractory manufacturer should engage in the further development of water-cooled refractory walls. Walls of refractories cooled by water tubes to prevent their rapid failure combine the desirable features of high temperatures in the furnace and efficient rapid heat absorbtion in the tubes.

Large Hydro Developments Being Made in Russia

By George Willock

THE question of water power in Russia is being carefully considered by the government, and a number of plants have recently been installed. The Soviet government officials consider that if new industries are to be developed there must be power available to drive them, and they have now in hand the construction of two exceptionally large plants; one on the River Dnieper in the southern part of the Province Ukraine, and the other on the River Svir, in the northern part of the same province.

Work on the first-mentioned plant is further advanced, and a large force of men are employed on construction work. The head has been obtained by building a dam across the River Dnieper, 130 ft. high and 2,300 ft. long, which floods out a series of rapids. Before the dam was built, the river Dnieper was not navigable, but now, by means of the locks at the dam, ships can proceed up the river for a considerable distance, thereby opening up the possibilities for developments of the southern parts of the country. The plant, which is situated near the town of Saporshie, has an available head of 120 ft., and with a flow of 28,000 sec.-ft., will develop normally not less than 350,000 horsepower.

Owing to the large size of the units required, it is of great importance that the machines should be the best possible, and to this end the Soviet government has ordered test turbines from a number of waterwheel manufacturers. Two test turbines were ordered from Aktiebolaget Finshyttan, Finshyttan, Sweden, the larger with a runner diameter of 25.5 in. and the smaller with a runner 10 in. in diameter. The former is in the scale of 1 to 7, and the latter 1 to 18 of what the actual turbines will be. A sectional arrangement of the larger of the two test turbines is shown in Fig. 1, and both are shown completed, in the shops, in Fig. 2.

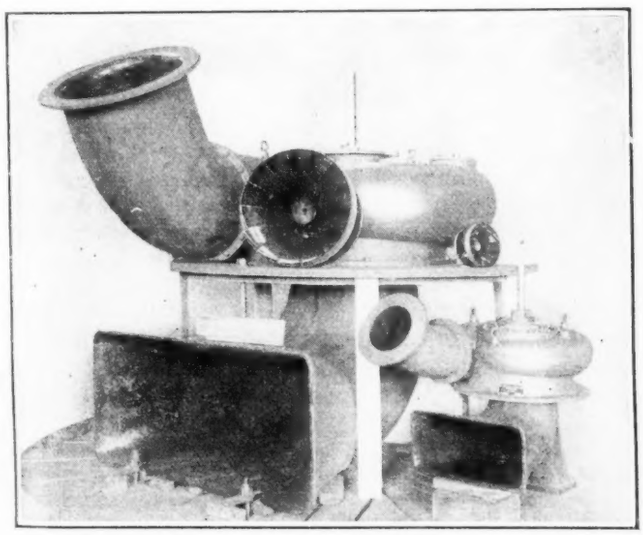


Fig. 1—Test waterwheels for the Dnieper River plant

These turbines will be tested by the Soviet government in its laboratory in Moscow, and the orders will be placed on the results obtained. As the tests will take a considerable time, it will probably be the latter part of this year before the orders will be placed. It can be mentioned that in the tests made by Aktiebolaget Finshyttan in their own test station, a maximum efficiency of 90 per cent was obtained with the 25.5-in. runner. The small test turbine will be incorporated with a model of the complete power house, so that investigations can be made under actual conditions.

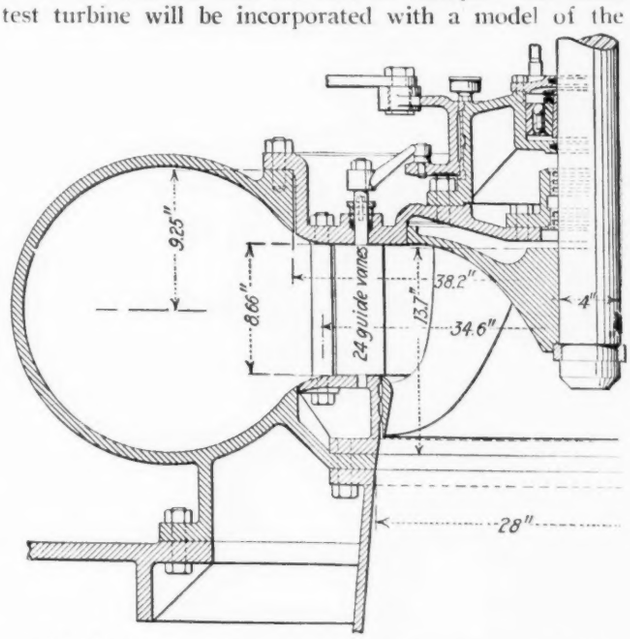


Fig. 2—Section through one of the test waterwheels

The actual turbines will have a runner diameter of about 15 ft. and will develop 63,000 hp. at a speed of 107 r.p.m. Five units will be included in the initial installation, and two will be installed at a later date. The power developed will be used in mines, electric furnaces with a yearly output of 3,000,000 tons of iron, and for the production of aluminum, ferro-manganese, etc., and also for the electrification of the province. The total cost of this plant is calculated to 44,000,000 rubles (par value $22,660,000).

A second plant on the River Svir will be unique in that the waterwheels will be, as far as dimensions are concerned, the largest ever manufactured. The design of the waterwheels, as proposed by Aktiebolaget Finshyttan, will be similar to those supplied by this firm to the Lilla Edet power station in Sweden, and as described in *Power* June 7, 1927. They will have much larger runners, having a diameter of about 25 feet.

This plant to start will consist of four units, each developing 35,000 hp. under a 360-ft. head at a speed of 75 r.p.m. Each runner will weigh about 80 tons.

The Outside Packed Plunger Pump is easier to repair when damaged by gritty water, is better adapted to pumping against high pressures, as the condition of the packing is known at sight, and is easier to repack than an ordinary piston pump. The plunger pump has the disadvantage of requiring more floor space and requiring more power for its operation than a piston pump of the same capacity.

Combustion Control Formulas

IX—Methods of controlling boiler operation

By E. A. UEHLING
M.E., Dr. of Engineering

THERE are three distinct methods for controlling boiler operation: (1)—The mechanical method, based on the ratio of the weight of water evaporated to the weight of fuel consumed; (2)—the synthetic method, based on the putting together and keeping in unison the steam-flow and air-flow records; (3)—the analytical method, based on the analysis of the heat losses and the separation of the savable from the unsavable heat in the flue gases.

The basic control factors of the mechanical method are determined by weighing or measuring the weight of fuel and water consumed or steam produced. Dividing the weight of water evaporated by the weight of fuel fired gives a rough index of the operating efficiency. The directness and simplicity of the mechanical method appeals alike to management and the operating engineer—to the former because in addition to apparent control it furnishes the principal data required to keep track of the cost of power, and to the latter because it introduces nothing unfamiliar to him and the calculations necessary to determine the index of the operating efficiency are very simple.

IN THIS article, the last of the series, the author compares the analytic method of controlling boiler operation with two other methods and discusses their advantages and disadvantages

The shortcomings of the mechanical method of control are manifold: (a) It lags too far behind the performance which it is supposed to control—at best a day but generally a week or month; (b) the shorter the intervals at which the index of efficiency is determined the less accurate it will be; (c) it does not lend itself to the control of individual boilers; (d) the efficiency index may be satisfactory even though one or more boilers in the battery operate quite wastefully while the performance of the others is excellent; (e) it gives him no clue to the cause of wasteful performance, hence leaves him groping in the dark for the proper remedy; (f) the index of efficiency may be affected to a greater extent by variation in the heating value of the fuel than by inefficient operation; (g) the crudeness of the mechanical method of control, when practiced unchecked by instruments, is generally not realized by the proprietor or manager of the plant, consequently the engineer and firemen may be unduly censured for results caused by factors over which they have no control.

The heating value of the coal may vary as much as 10 per cent owing to the variability in the ash and moisture it contains, which, for reasons well known to every operating engineer, will result in a much greater variation in the weight of water evaporated per pound of coal fired than the variation in the heating values. The irregularities in performance due to the foregoing cause can be accounted for only if the analysis of the coal used and its heating value are known. Such analysis, if the engineer gets them at all, arrive at best a week or a month late. They do not correctly represent the coal he is firing at the time and are therefore of no real control value. There are many variable factors that affect the evaporation and must be taken into account before the mechanical method can lay claim to practical accuracy. Some of these factors are feed-water temperature, blow-off water, banking, etc.

Before a remedy can be effectively applied, an accurate and intelligent diagnosis must be made. This applies as truly to the engineer as it does to the doctor. The doctor who prescribes a remedy without having made a thorough examination of his patient is a quack, and the engineer who regulates his engine and boilers by guess is in the same category. Every engineer in charge of a power plant of 200 hp. or over should insist upon being equipped with an indicator to diagnose his engines and an orsat and portable pyrometer to diagnose his boilers. By diligent and intelligent application of these instruments the operation of any power plant can be improved and most of them brought to a high plane of efficiency. The orsat is to the boiler what the indicator is to the engine. Both are instruments for diagnosing performance. An engine can be kept in practically perfect adjustment by a monthly diagnosis of its performance. To keep the factors that enter into the performance of a boiler adjusted and in proper relation to one another, continuous diagnosis is necessary, because the conditions on which the factors of performance depend vary continuously. Thus, while high efficiency can be established by the aid of an orsat, it can be maintained only by the aid of a continuous CO_2 indicator and recorder.

The mechanical method of control is by itself of no help to the operating engineer except as an incentive to improve the operation of his boilers. It is, however, of great value to the manager as a direct control over the cost of his power and in a way also over his operating personnel. Fuel is by far the greatest item in the cost of power, and the mechanical method of boiler control furnishes the data required for keeping close watch over this important item. Its importance to the management is therefore evident.

The synthetic method of controlling boiler operation is based on the presumption that it is just as logical to assume that air is burned by fuel, as it is that fuel is burned by air, and that the heating value of one pound of air is practically constant when burned with any given class of fuel. For example, one pound of carbon will completely burn 11.6 lb. of air and will liberate 14,600 B.t.u. Therefore one pound of air burned by carbon will liberate $\frac{14,600}{11.6} = 1,260$ B.t.u. Also, one pound of hydrogen will completely burn 34.8 lb. of air and liberate 62,000 B.t.u. Therefore, one pound of air will liberate $\frac{62,000}{34.8} = 1,780$ B.t.u., hence 1,780 B.t.u. is the heating value of one pound of air burned by hydrogen.

Air is therefore by no means equicalorific; it necessarily varies with the value of available hydrogen, but since H_a is practically constant in each class of fuel, it follows that the heating value of one pound of air when completely burned must also be constant for any given class of fuel. The heating value per pound of air is readily determined for each class of fuel by the simple formula, $1,254 + (1,780 \times H_a)$ = B.t.u. per pound of air burned. Inserting the respective values of H_a in each class of fuel, we find the theoretical heating values of air to be as follows: Anthracite coal, 1,310 B.t.u. per pound of air; semi-bituminous coal, 1,347; bituminous coal, 1,356; sub-bituminous coal, 1,344; fuel oil, 1,500; natural gas, 1,800. Thus, while the theoretical heating value of a pound of air is practically constant for each class of fuel, its effective heating value is by no means constant in actual practice. The excess air affects the available heating value of air to a far greater extent than the ash affects the heating value of coal. This is so because the heat carried to waste by the refuse is small compared with the heat carried to waste by excess air.

It is evident, none the less, that the air may be taken as the source of heat and the fuel as the supporter of combustion instead of the generally accepted way. But since the effective heating value of air supplied to the furnace depends on the per cent of excess air, its heating value can be maintained constant only by supplying a constant per cent of excess air to the furnace, which means a constant per cent of CO_2. If this is done, then the rate of air flow will be an index of the rate of heat supplied to the boiler. Furthermore, all the heat absorbed by the water in the boiler is contained in the steam produced, and if we know the heat it carries per pound the rate of heat output can be readily determined by measuring the rate of steam flow from the boiler. Now if these two control factors are graphically recorded in terms of B.t.u., the ratio of the rate of steam flow to air flow will be an index of operating efficiency.

The synthetic method of control of boiler operation based on the foregoing relation between steam flow and air flow is embodied in the most practical form in the Bailey combustion meter. In this instrument the steam flow and air flow are recorded on the same chart and the records are synchronized in such a manner that they will coincide when the highest practical efficiency obtains. This efficiency must be predetermined by tests. The adjustments remain fixed until changes in the boilers or conditions of operation make readjustments advisable or necessary.

The points most highly commendable in this method of control are: (*a*) It places before the fireman a continuous up-to-the-minute record of the performance of every boiler in his charge. He can see at a glance when the airflow becomes excessive or deficient and can immediately make the proper fuel and damper adjustments to bring flow records into unison. (*b*) The heat of combustion being based on the heating value of the air makes the control independent of the irregularities of the heating value of the fuel. (*c*) The control factors are recorded and hence free from personal equation. (*d*) The engineer can see whether his boilers are operating with maximum efficiency without making troublesome calculations.

The synthetic method would be the most excellent method of control if it did not have the following defects:

1. The ratio of the rates of steam flow to air flow that will give maximum boiler efficiency must be determined by actual tests, and to be reliable these tests and also the necessary recorder adjustments must be made by an expert. This evolves a personal equation, which may be objectionable.

2. The airflow recorder is actuated by the draft required to draw the gas through the boiler and therefore is affected by the condition of the heating surface as well as the baffling.

3. The airflow record is in reality an index of the gas flowing through the boiler. Since the volume of gas produced by burning a given weight of air varies with the average temperature and the temperature varies with rate of driving as well as the condition of the heating surface, the record of the weight of air flowing is also affected.

COMBUSTION CONTROL FORMULAS

$(X - X_m) \times T_w$ = B.t.u. controllable heat loss due to excess air

$X_m \times (T - T_w)$ = B.t.u. controllable heat lost due to excess temperature

$(X - X_m) \times (T - T_w)$ = B.t.u. controllable heat lost due to both excess air and excess temperature

$Y \times 10,160$ = B.t.u. controllable potential heat in dry gas

$H_t \times 4.3\ (T - T_w)$ = B.t.u. controllable sensible heat due to water vapor.

$= \frac{a \times pc}{1 - pc} \times 14,600$ = B.t.u. controllable potential heat in ash

$X = 0.24 + \frac{58.46}{CO_2} = X_m$ when CO_2 is maximum attainable

$Y = \frac{CO}{CO + CO_2}$

H_t = Weight of hydrogen in fuel per P.C. unit

a = Weight of ash in fuel per P.C. unit

pc = Per cent carbon in refuse

T = Temperature of flue gas, T_w = temperature of water in boiler

4. Both the air and feed water temperatures affect the adjustment of the air-flow record, and since both may vary considerably, the adjustment will be out that much.

5. It does not account for the heat loss through the grate.

6. If the meter is adjusted so that maximum combustion efficiency exists when the air-flow steam-flow records coincide, either an increase or a decrease in excess air will cause the steam-flow record to be below the air-flow record, and the fireman will thus have no way of telling whether to increase or to decrease the air supply in order to bring the two records together.

If, however, the meter is not set for maximum efficiency, a decrease in excess air will cause the air-flow record to fall below the steam-flow record, but up to a certain point there will result an improvement in combustion. Thus if the operator follows instructions and brings the two records together, a possible saving in fuel will be lost.

It is recognized that, in many cases, and particularly at high ratings, the furnace design limits the degree of approach to maximum combustion efficiency that can be attained without causing serious refractory troubles.

7. Last but not least, the synthetic method does not record the data necessary to calculate and analyze the heat losses up the chimney, so helpful in controlling boiler operation.

These defects may be serious or not, according to how well the best operating conditions are maintained. If the boilers are kept tight and clean and the baffling intact, the synthetic method of control is a vast improvement over the mechanical method.

The Analytic Method of Control

The analytic method of controlling boiler operation is based on the controllable heat losses. There is only one way by which the controllable heat losses can be determined with practical accuracy. The products of combustion must be analyzed for the controlling constituents, and the temperature at which they leave the heating surface of the boiler must be determined and the temperature of the water in the boiler must be known. The uncontrollable heat losses depend on the steam pressure and the class of fuel used. They are unavailable to the boiler and practically constant and therefore have no control value. The controllable heat losses depend on three factors: Excess air, of which CO_2 is the index; incomplete combustion, of which CO is the index, and excess temperature, of which $T - T_a$ is the index.

These four indexes are necessary and adequate for the intelligent economic control of boiler operation. They give all the information necessary for attaining and maintaining maximum operating efficiency. This has been amply demonstrated in the preceding articles. The analytic method implies that the four fundamental indexes are recorded on one chart, preferably in the engineer's office; also that they are indicated at or near the boiler front.

The method of control, as the name implies, analyzes the heat losses and separates the uncontrollable losses from those that are controllable. The former being unavailable to the boiler and practically constant for any given fuel and operating condition, are ignored, because they cannot be reduced. It divides the controllable heat losses up the chimney into three components: (*a*) Loss due to excess air, (*b*) loss due to incomplete combustion, and (*c*) loss due to excess temperature. Losses *a* and *b* control combustion, and *c* controls adsorption efficiency. The firemen are responsible for the first two loss components, and the boiler cleaners are responsible for the third. The firemen are further controlled by the product of $CO_2 \times \sqrt{Bd}$, which is an approximate index of the rate of combustion.

The analytic method of control not only shows at a glance how the boilers are functioning, but also shows who is responsible for any appreciable deviation from the attainable maximum efficiency. Furthermore, the records furnish all the data necessary to determine the heat losses in B.t.u. upon which an equitable bonus system, based on actual saving, can be established.

The reliability of the analytic method of control is not affected by any of the factors which more or less seriously affect the economic results obtained by either of the other two methods. Since it is based on the heat wasted instead of the heat utilized by the boiler, it is immaterial whether heat comes from the fuel, the air or the feed water, as the boiler will always absorb the difference between the heat supplied and the heat lost. To maintain the former at a maximum, the latter must be kept at a minimum. Ignoring the uncontrollable heat losses greatly simplifies the heat loss calculations without appreciably affecting their accuracy.

The three methods of controlling boiler operation compare as follows:

In the mechanical method of control

$$\frac{\text{Weight of water evaporated}}{\text{Weight of fuel fired}}$$

is a rough index of operating efficiency. Its one point of superiority over the other two methods is that it includes the ashpit loss. Its two greatest defects are that it shows up only past performance and that it furnishes no data upon which an intelligent diagnosis can be based.

In the synthetic method of control the relation of the steam-flow and air-flow records is the index of operating efficiency. Its points of superiority over the mechanical method are that its indexes are graphically recorded, that the records are immediate and the records are in plain view of the fireman for his guidance. Its defects are: (1) It does not furnish the necessary data for an intelligent diagnosis; (2) it is affected by variations in temperature of both air and feed water; (3) it does not include the ashpit loss, and (4) it furnishes no direct data for calculating heat losses.

In the analytic method of control

$$\frac{\text{Heat in the fuel fired—controllable heat in flue gas}}{\text{Heat in fuel fired}}$$

= practical operating efficiency of furnace and boiler. The points of advantage are: (1) It graphically records all the data required for an intelligent diagnosis; (2) it is not affected by variations in the source of heat, heating value of the fuel, temperature of air and feed water; (3) it records in the engineer's office and indicates at the boiler front; (4) it furnishes all the data necessary to calculate the heat losses, per cent of excess air, etc.; (5) its records and indications are also practically immediate. Its defects are due: (1) To the difficulty in drawing a continuous average sample from the gas stream which may flow in strata of varying composition; (2) this also holds true for the temperature of the gas leaving the

boiler; proper location of sampling tubes and pyrometer, however, reduces the probable errors due to the foregoing causes; (3) it does not record the ashpit losses. The instruments for the continuous diagnosis of boiler operation are not required nor purported to be instruments of precision. The essentials in a boiler-house instrument are simplicity, reliability and practical accuracy.

The three methods of controlling boiler operation described and criticized herein were considered as consisting of their fundamental parts only. There is no reason why the mechanical method should not be supplemented with multiple draft gages, CO_2 recorder and pyrometer. In fact, all progressive operating engineers are clamoring for, and alert managers are supplying, these instruments. Notwithstanding the good results obtained by the synthetic method of control, there is no doubt that the operating efficiency could be materially bettered by adding a combined CO_2 and CO recorder to the equipment. And although the analytic method records all the data for complete economic control, the steamflow meter would be a desirable addition. Multiple indicating draft gages should be included in all three methods of control. Coal weighers and water meters are desirable in all cases as over-all controls.

In closing this series of articles it is realized that the general subject treated in this and the preceding articles has not been covered in every detail, nor is it expected that the practical operating engineer will be able to absorb all of the underlying fundamental principles in one reading.

Neglecting Boiler Room Instruments

By A. J. Bell

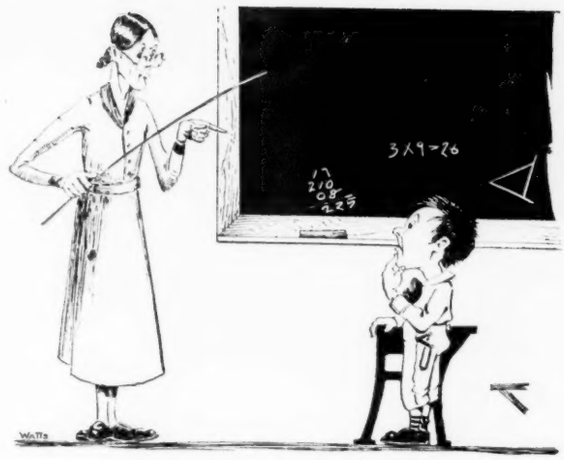
IN NO other part of the plant are instruments so vital as in the boiler room, especially the recording instruments.

This does not apply so much to the larger plants, such as central stations, but to the small isolated manufacturing plants burning from one to five cars of coal per day. The larger stations usually have some one such as the boiler room engineer to look after these things, while their care is no one's business in the small plant.

Many plants have such things as CO_2 recorders, coal scales and steam-flow meters lying idle and accumulating dust because no one ever pays any attention to them.

It seems that at some time during the life of such a plant somebody had the happy idea of efficiency and bought some equipment to improve it, but through the error of not buying enough of the right kind or the right type, it soon fell into disuse, either through neglect or the inability of the operator to understand its use.

Take, for instance, a boiler room that is equipped with scales arranged so that the coal fed to each boiler is weighed. If there are no steam-flow meters on each boiler, the coal scales tell only the coal burned and not the evaporation. On the other hand, with flow meters on each boiler the evaporation can be figured every day, and with a few other items the coal cost per thousand pounds of steam can be known. Likewise, the boiler that is not making the right amount of steam can be singled out for the necessary repairs. For the same reason a CO_2 recorder is not of much use without a good draft gage to tell the condition in the furnace when the CO_2 was low.



What Do You Know?

By L. H. Morrison

The answers are on page 350

Ques. 1—Why are the bolts used to hold crankpin bearing halves turned down smaller than the threaded portion?

Ques. 2—Will the stress on a connecting-rod bolt, where no shims are used between the two bearing halves, be the sum of the initial tension and the running load?

Ques. 3—In making up high-pressure flange joints, would you use as many bolts with turned bodies as you would if the bolts were threaded their entire length?

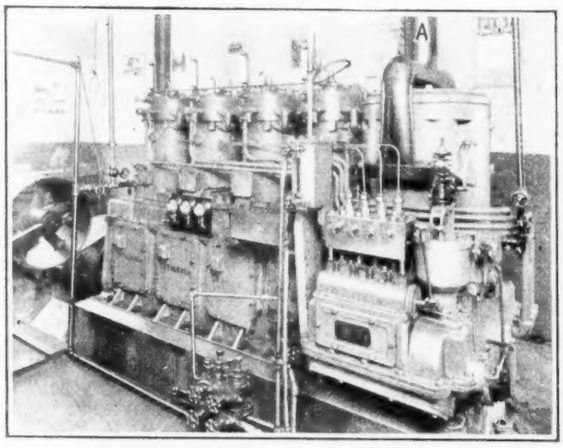
Ques. 4—If the head of a barometric condenser is 36 ft. above the level of the tailrace, can water be pulled over into the engine?

Ques. 5—How many heat units are equivalent to one horsepower-hour?

Ques. 6—How long should be the splice in a leather belt?

Ques. 7—In a direct-acting pump will the steam-end efficiency increase or decrease with an increase in superheat?

Ques. 8—For what use is the pipe marked *A* in the illustration?



The illustration referred to in Question 8

Jeannette Testing Plant*

Equipment Used to Test Condensers, Ejectors, Etc.—Separately Fired Superheater—Steam Is Generated at 400 Lb. Pressure

THE testing plant at the Jeannette, Pa., works of The Elliott Company represents an ambitious undertaking. While primarily designed for turbine testing, it is also provided with complete facilities for the testing of pumps, ejectors, vacuum boosters, and condensers. The steam supply for the test plant comes from the high-pressure boiler and superheater shown in Figs. 1 and 2, making pressures of over 400 lb. per sq.in. and temperatures of 750 deg. available for tests.

As it is not practical to use anything but distilled water in boilers of this high-pressure type, the boiler feed is obtained from the condenser of the 750-kw. turbo-generator set used to generate the power used in the shops. This unit continually discharges its condensate into a 40,000-gal. tank, and while the instantaneous demands of the test plant may exceed the constant supply of condensate, nevertheless, the load factor of the test plant is such that sufficient condensate is supplied for the general testing work. The boilers are oil fired, the management deciding that the ease of control and regulation of an oil-fired boiler was far greater than that of coal-fired units. The superheaters are placed in separate settings and are entirely independent of the boilers, so that the temperatures are under absolute control. Steam-driven fuel pumps supply oil for both the superheaters and the boilers from underground concrete tanks, located at some distance from the boiler plant. The 5,000-sq.ft. surface condenser which handles the steam from the turbines or ejectors that are being tested is shown in Fig. 3. Owing to soil conditions it was not feasible to excavate for the usual sub-floor condenser pit, so the condenser is placed on the working floor. The condenser receives water from the spray pond, and turbines as large as 5,000-kw. may be completely tested and running tests are given even larger turbines. The pit containing the exhaust pipe leading to the condenser is partly shown in Fig. 3, while in Fig. 5 this pipe, which is about 80 ft. long, runs in the trench with valve connections for attaching the turbines to be tested. Portions of this line may be isolated, so that turbines may be operated non-condensing if desired, while condensing tests are being conducted upon other turbines. Careful attention had to be given to the steam piping on account of the high pressures and temperatures. This explains the number of expansion bends shown in Fig. 4. As a matter of fact, from the boiler to the end of the pipe line, a 9-in. expansion occurs when 750 deg. F. steam is used. The vertical bends shown hanging to the main header have Van Stone joints so that they may be swung into the most convenient position for connecting up to the turbines to be tested.

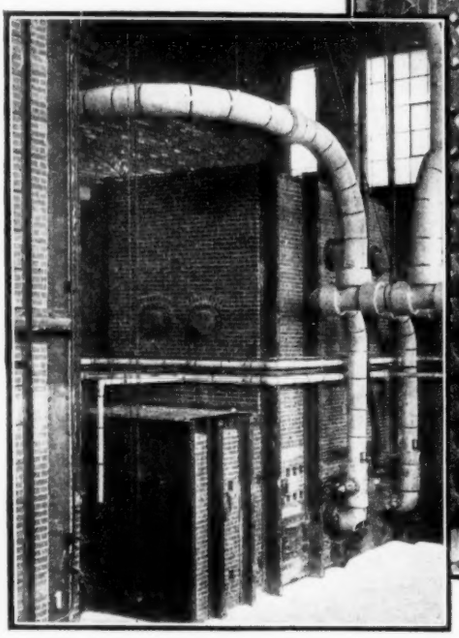


Fig. 1—A separately fired superheater is used

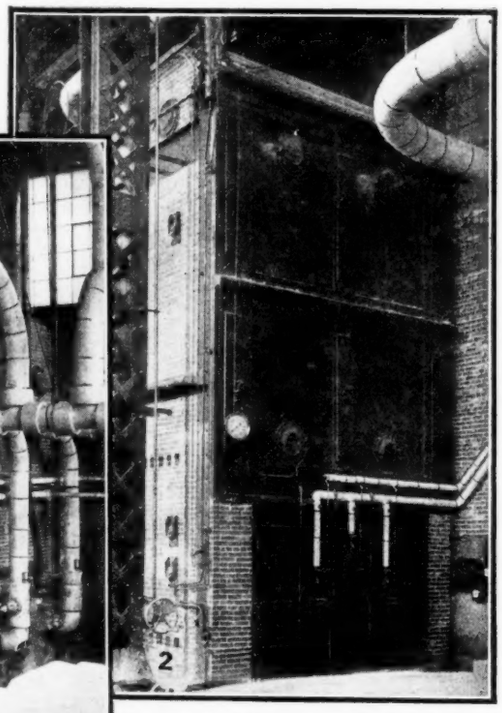
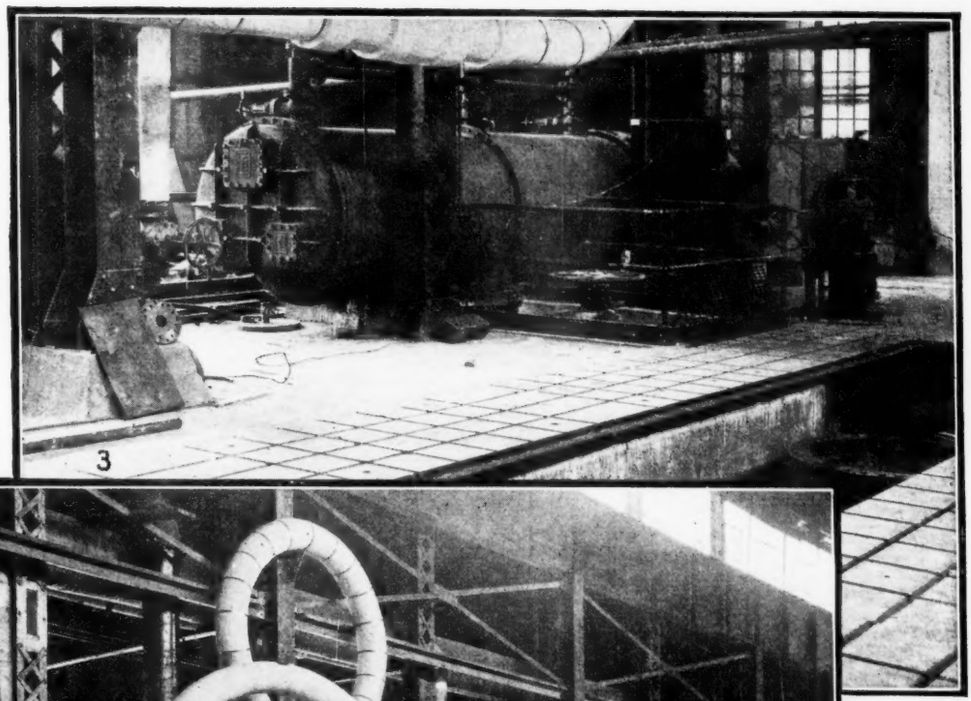


Fig. 2—The water tube boiler is designed for high pressure

Outside of the building, provision is made for water rheostats so that alternating-current loads up to 5,000 kw. may be easily handled, and direct-current loads up to about 1,250 kw.

The ejector test floor is arranged to test any commercially conceivable ejector, and it is the policy of the company to test every ejector before shipment. The ejector test floor is in the portion of the plant on the far side of the columns supporting the steam line shown in Fig. 4. Tests can simultaneously be made on different ejectors at different steam pressures with either saturated or superheated steam. In the same bay as the ejector tests there is a large water pit for use in pump testing. In addition to this testing, a continuous program of research is carried out.

*This article is based on information supplied by the Elliott Company in *Powerfax*.



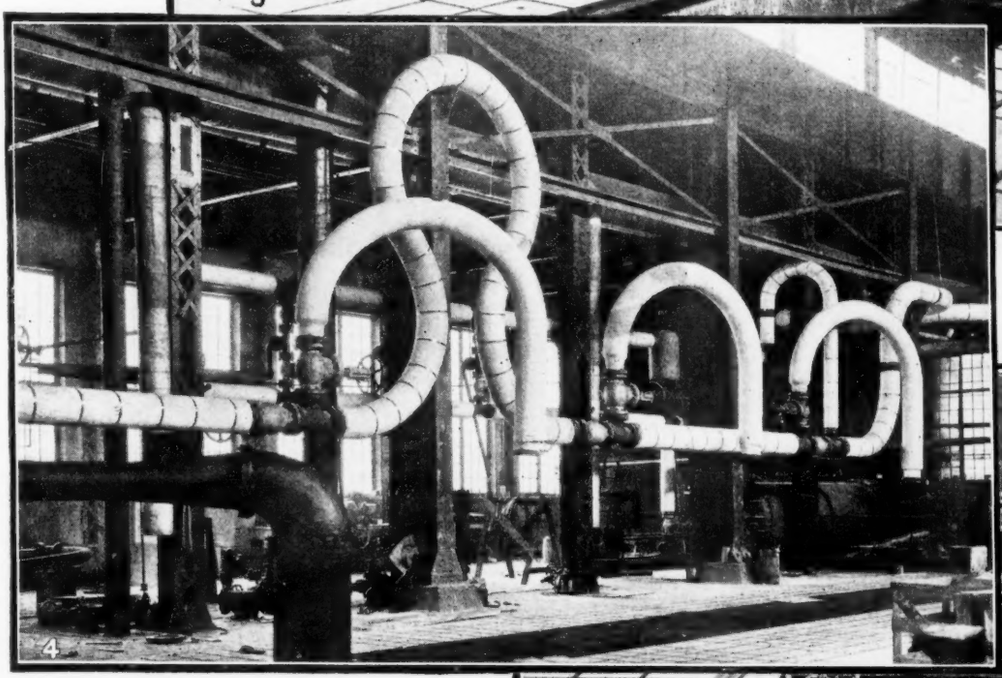


Fig. 3—The condenser used in testing

Fig. 4—The steam lines are supplied with expansion loops

Fig. 5—View of pit and exhaust connection

Design and Application of
Traveling-Grate Stokers

By T. A. MARSH
Western Engineer, Combustion Engineering Corporation

THERE is today no reason for the misapplication of stokers, from the viewpoint of such items as suitable fuel or load conditions. This is an advance over the practice of the previous decade, during which there was considerable uncertainty as to the proper type of stoker to meet a given set of conditions.

The types of stokers most suitable for various fuels are as follows:

FUEL	PREFERABLE STOKER
Anthracite	Traveling forced-draft grate
Coke Breeze	Traveling forced-draft grate
Semi-anthracite	Traveling forced-draft grate
Semi-bituminous (coking)	Underfeed and inclined overfeed
Bituminous (coking)	Underfeed and inclined overfeed
Bituminous (free-burning high-ash above 10 or 12%)	Forced or natural-draft traveling grates
*Bituminous (free-burning low-ash, below 10 or 12%)	Traveling grates, underfeed or side inclined
Sub-bituminous Coal	Traveling grates forced or natural draft
Lignite	Traveling grates forced or natural draft

*If ash fuses at a temperature below 2,400 deg. F., traveling grates are preferable. If the percentage of ash is less than 7, underfeed stokers are preferable.
The term "traveling grates" is used to cover chain grates as well as traveling carrier bar stokers.

The two first-mentioned fuels, anthracite and coke breeze, are practically limited to forced-draft traveling grates. Bituminous coal, sub-bituminous coal and lignite

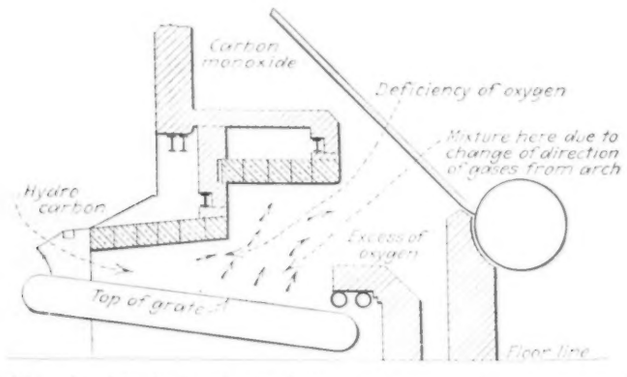


Fig. 1—Method of obtaining mixture of oxygen and hydrocarbon in chain-grate furnace by impingement

are suitable for either forced- or natural-draft stokers. Whether forced- or natural-draft chain grates shall be used is primarily dependent upon the nature of the load and ratings demanded.

Before discussing chain grates and the accompanying furnaces in detail, it is well to consider the characteristics of this type of stoker. Chain grates maintain an undisturbed fuel bed, and discharge ash and refuse continuously. These functions make this type of stoker suitable for high-ash and clinkering coals. Coals having as high as 40 per cent of ash are successfully handled and are standard fuels in some plants.

NATURAL-DRAFT STOKERS

Natural-draft chain grates with adequate draft provision may reach combustion rates as high as 40 lb. of coal per square foot of grate surface per hour. This

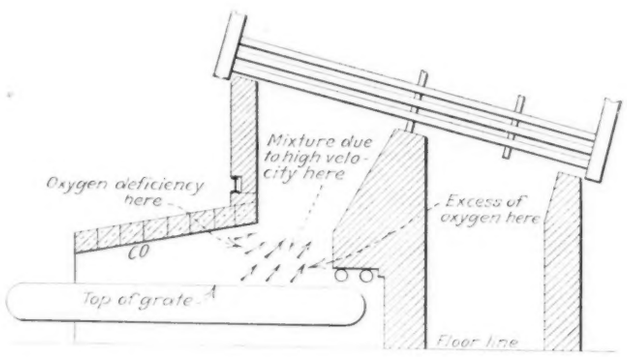


Fig. 2—Method of obtaining gas mixture in furnace by high velocity

figure, however, is under ideal conditions and is too high to count on for dependable operation. A safer combustion rate to use as the limit for proportioning grate areas is 38 lb. as a maximum. The draft required in the furnace for various combustion rates with natural-draft chain-grate stokers, is approximately 0.1 in. for each 10 lb. per square foot of grate surface per hour of coal burned.

Natural-draft chain grates can be operated at rates of combustion of from 10 to 35 lb. of coal per square foot of grate surface with 12 to 13 per cent CO_2 in the flue gases and with the amount of combustible in the ash below 15 per cent.

An outstanding characteristic of chain grates is ease of maintaining smokelessness. This is due to the uniform and continuous feeding of fuel, undisturbed fuel beds and the use of liberal arches to maintain high temperatures. This is an important feature of chain grates, considering the high-volatile coals burned, and renders them highly suitable in cities where smokelessness is a requirement.

Most natural-draft chain grates operate within a combustion range of from 20 to 30 lb. of coal per square

foot of grate surface per hour. However, they can be operated at good efficiency at combustion rates as low as 5 lb. per square foot of grate surface per hour. It is well, therefore, to operate a natural-draft chain-grate plant at low ratings rather than to bank the stokers. The amount of coal required for banking is approximately 0.05 lb. per sq.ft. of boiler-heating surface per hour; that

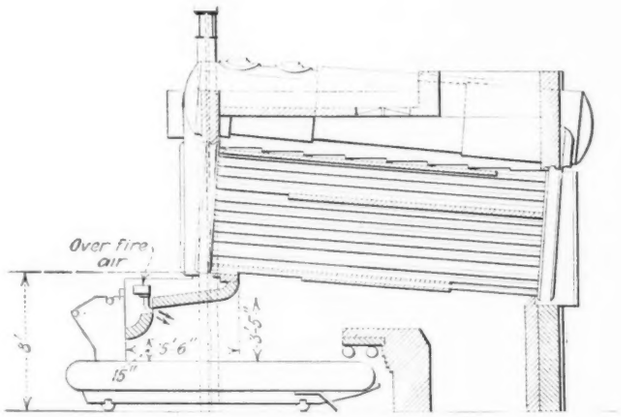


Fig. 3—Type of modern chain-grate furnace used with Mid-West bituminous coals

is, a 5,000-sq.ft. boiler would require approximately 250 lb. of coal per hour for banking.

Chain grates operate with low maintenance costs. The fact that the grate surface is exposed to actual service for only approximately one-third of the operating hours, is doubtless a big factor with regard to long life of the parts most exposed to heat effects.

The limitations of chain grates are in their responsiveness to sudden load demands, particularly if the demands come unexpectedly. They cannot be brought from a banked condition to full load as quickly as underfeed stokers. Preheated air cannot be applied to natural-draft chain grates, as there are no closed compartments to confine it. Moreover, most natural-draft stokers have to undergo redesign to make them adaptable to high preheat from the viewpoint of maintenance.

All chain grates are basically coal conveyors. Without refinements the chain grate remains no more than a conveyor and the efficiency of combustion is low. By refinements are meant adequate air seals to prevent unneeded air from short-circuiting around the rear of the grate and through the rear portion of the grate surface into the furnace, and also air seals between the sides of the stoker and the walls of the furnace. To carry the air seal to completion, it is necessary to use a waterback over the stoker.

Tight air seals are made between the grate surface and furnace walls by means of adjustable ledge plates. It is also necessary to have a tight damper between the upper and lower leads of chains at the rear, a seal below the lower chain, and seals at the sides between the stoker frames and side walls corresponding with the seal between the stoker chains.

Above the stoker the seal should be completed by an overhanging bridge wall and waterback set close enough to the grate surface to make a practical seal with the fuel bed. The cost of proper refinements for air exclusion is well warranted and is the price of an efficient installation. A 15 per cent fuel difference is not unreasonable between a properly and improperly made chain-grate installation.

Furnaces for Natural-Draft Chain Grates

The essential features of chain-grate furnaces are:

1. An arch to maintain high furnace temperatures and ignite fuel.
2. Admission of air at proper location and in proper quantity.
3. Means for mixture of air and gases distilled from the fuel.
4. A chamber of sufficient size to provide time for combustion.

Satisfactory furnace performance is a reasonable balance among capacity, efficiency and maintenance. If any one of these three is improved at the undue expense of one or both of the others, it produces unsatisfactory results. Consider maintenance; arches constitute a major item of maintenance in boiler room operation. Arches of excess length are subject to excessive maintenance. It is therefore the problem of the furnace designer to design arches of minimum length and to place them

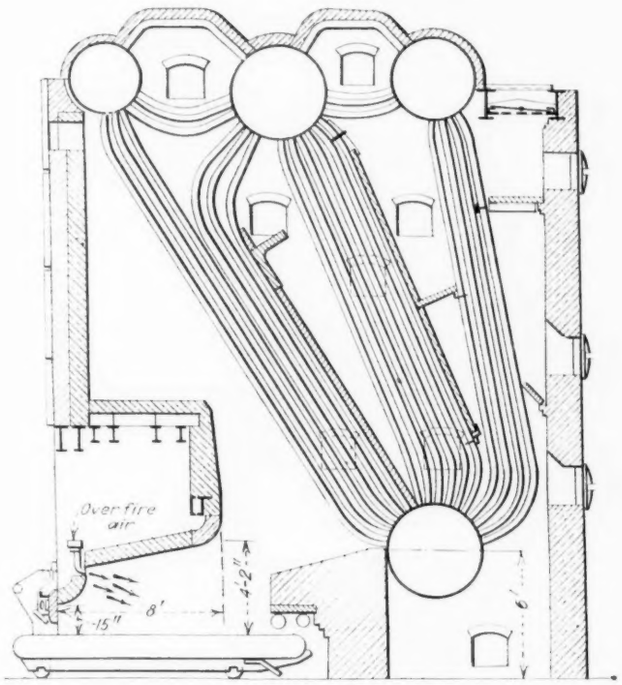


Fig. 4—A second type of chain-grate furnace used with Mid-West bituminous coals

in such a position that the full requirements of the furnace can be secured under the most difficult operating conditions.

It is essential to locate the arch so that it shall be subjected to high furnace temperature and also be placed so that sufficient radiation to the fuel bed is obtained. The position in the furnace where maximum temperatures may be obtained does not always coincide with the position most favorable for radiation to the front of the fuel bed. It is undesirable to locate an arch or portion of an arch in a position where temperatures are unduly high if ignition effects and other arch functions can be

obtained by some position less exacting from a maintenance standpoint.

Arches with an excess of ignition effect are subjected to unduly high maintenance and the furnace is a misdesign as truly, though not as perceptibly, as if the fuel could not be ignited. The factors to consider so far as ignition is involved, are:

1. The ignition temperature of the fuel.
2. The heating value of the fuel.
3. The quantity to be ignited per foot of furnace width per hour.

Low-grade coals require longer arches than high-grade coals in order to produce the same results as to ignition. Frequently, for reasons of providing a mixture of furnace gases to produce smokelessness or complete combustion, arches must be made longer than actually demanded so far as fuel ignition is concerned. Arch heights that have given best results in natural draft practice, are 36 in. above the grate at the front and pitched slightly upward toward the rear.

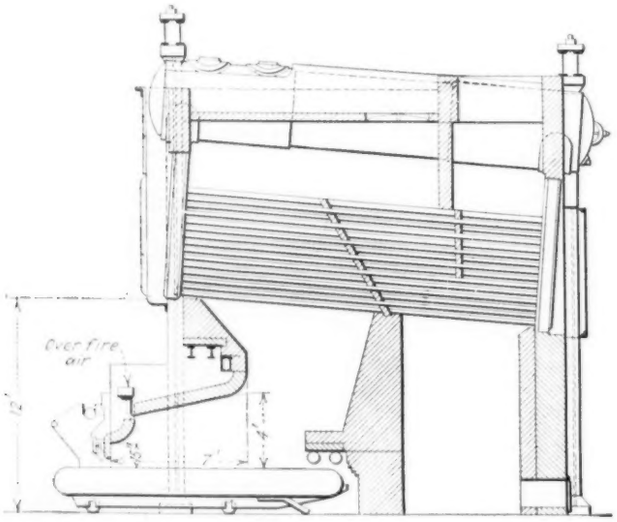


Fig. 5—A third type of chain-grate furnace used with Mid-West bituminous coals

Supplying Air for Combustion

Having a furnace so designed that fuel will be properly ignited, the next thing is to supply the air for combustion at the proper location. It is not possible to supply air for complete combustion through a compact fuel bed. Chain-grate fuel beds are compact at the front portion and porous at the rear. Therefore, a condition exists wherein there is a deficiency of oxygen in the furnace over the fire in front and an excess at the rear. In some furnaces it is possible to divert the gases high in oxygen from the rear to the front. In many instances, however, a flow of gases from rear to front is not possible. In such cases the deficiency of oxygen over the fuel bed in front must be supplied by means of the admission of auxiliary overfire air. This can be done crudely by cutting air holes through the front of the arch, or air can be blown through a header with nozzles by means of steam jets. The former method is inefficient; the latter is costly to operate, owing to the steam consumption. The most approved system of overfire air application is to introduce the air through properly designed nozzles by means of a fan.

With coal ignited and air introduced at proper locations, the next item to provide for is mixture. Mixture or turbulence is necessary to bring oxygen in contact with combustible. Furnaces such as shown in Fig. 1 afford a good degree of mixture, due to a stepped-up arch at the rear of the furnace. Furnaces with narrow outlets such as shown in Fig. 2, provide a mixing section at the narrow throat of the furnace where gases pass at high velocity. Overfire air introduced through nozzles, directed downwardly toward the fuel bed, provides the necessary turbulence and mixing required to produce good combustion.

It is necessary to have furnaces of ample size to permit time for the reactions of combustion. This is a matter for study on the part of the furnace designer. Boilers set too low provide insufficient furnace, which means that there is not room for combustion in the furnace, prolonging combustion into the boiler passes with disastrous results to efficiency. With insufficient furnace smokelessness is not possible. Boiler tubes foul with soot and heat transmission is reduced.

The minimum and preferred heights for various types of boilers have been determined by the Stoker Manufacturers Association. The standards for natural-draft chain grates are given in Table I. Most installations are made with boilers at greater heights to provide more liberal furnaces. Some typical modern chain-grate furnaces as used with Mid-West bituminous coal are shown in Figs. 3, 4 and 5.

TABLE I—STANDARD SETTING HEIGHTS FOR NATURAL DRAFT CHAIN GRATES

Type of Boiler	Setting Height in Feet—Minimum	Preferred	
Water-tube			
Horizontal	10	12	(floor to header bottom)
Inclined (hor. mud drum)	6	8	(center of mud drum)
Inclined (vert. mud drum)	3	5	(top of mud drum)
Vertical (hor. mud drum)	3	4	(center of mud drum)
Vertical (vert. mud drum)	$4\frac{5}{12}$	$4\frac{7}{12}$	(top of mud drum)
Horizontal return tubular	7	8	(under side of shell)

Fuels for Chain Grates

The usual chain-grate coal has been $1\frac{1}{4}$-, $1\frac{1}{2}$- or 2-in. screenings. Careful operators have analyzed their ashpit losses in connection with coals of various sizes as determined by screen tests, and have found that excessive losses occur due to the percentage of larger pieces found in the average screenings. Smaller coal is being sought. It is now recognized that the best specifications for chain-grate coals are that all pieces should pass through a 1-in. round hole and that there should be a minimum of fines or dust. By the use of coal of such sizes higher ratings can be obtained from stokers and ashpit losses can be kept low.

It is recognized that definite benefits result from the proper tempering of fuel for chain grates. The effects of the added moisture are physical rather than chemical and result in the following combustion advantages: decreased sifting of coal; fewer holes in the fuel bed, hence less excess air; higher combustion rates with a given draft; improved quality of ash; better ignition. The amount of moisture to be added for tempering purposes is slight, usually about 3 per cent of the weight of the coal. So far as the heat required to evaporate this small

amount of water from the coal is concerned, it is negligible (only about 0.3 per cent of the heat in the coal). The physical effects of tempering are such that an interval of time is required between tempering and firing (preferably an hour or more).

Tempering should therefore be done on coal conveyors or in bunkers, rather than in stoker hoppers. Very little success has been noted with attempts to temper coal in stoker hoppers unless hot water or exhaust steam has been used.

Chain grates are easy to operate. There is no periodic firing and ash dumping. Actual firing operations are therefore simpler and easier than with other types of stokers. The continuity of operation makes it possible to maintain desirable conditions of furnace and fuel bed. It is not unusual for weekly or monthly operations to approach to within 2 or 3 per cent of best test conditions.

The results to be obtained from various fuels may be judged from Table II. The range of fuels covered by this tabulation is wide, but serves to show the performance to be anticipated from natural-draft chain grates over a broad range. The performance on lignite, while of interest as a matter of record, is not considered commercial, as furnace conditions with such fuel under natural draft conditions, are very sensitive and difficult to maintain. Preferable methods of burning lignites are either in pulverized form or by forced draft with highly preheated air.

Test results are of interest for the information derived. More important, however, are actual operating records covering a considerable period of time. Table III gives the performance of ten natural-draft stoker plants for periods of from one month to twelve months. These figures are submitted as actual plant records and show the possibility of this type of stoker in daily operation.

From the characteristics and results, therefore, it is evident that the natural-draft chain grate has a definite field. This method of firing has survived for over a century. There are now boilers so fired with over 25,000,000 sq.ft. of heating surface in the United States. It is evident that this type of stoker will continue to be used for many years to come.

TABLE II—TESTS RESULTS WITH VARIOUS FUELS BURNED ON NATURAL-DRAFT TRAVELING STOKERS

Name of Coal	Moisture Per Cent	Per Cent Volatile	Per Cent Fixed Carbon	Per Cent Ash	B.t.u. per Pound A.F.	Lb. Coal Burned per Sq.Ft. of Grate per Hr.	Draft in the Furnace	Per Cent Combustible in Ash	Per Cent CO_2
Illinois	9.5	30.01	50.94	11.35	12,010	31.4	0.34	18	12.4
Indiana	11.06	33.52	41.47	13.95	11,118	29.0	0.32	16	12.3
Iowa	16.31	30.06	32.47	21.16	8,435	35.08	0.36	16	12.6
Arkansas	4.25	14.28	58.89	22.58	10,874	32.1	0.27	22	12.9
New Mexico	19.55	34.00	35.53	10.92	8,367	40.2	0.27	15.9	15.5
Texas	3.81	35.41	40.23	21.55	11,200	24.6	0.23	22.3	9.7
Oklahoma	6.27	27.93	46.37	19.43	10,706	27.5	0.23	26.9	12.6
Wyoming	20.52	31.23	30.00	9.25	9,096	35.0	0.36	17.4	12.6
Montana	15.27	41.24	30.91	12.85	9,553	31.8	0.17	20.71	12.0
Colorado	23.73	35.25	33.23	7.79	8,511	28.0	0.23	....	12.0
Texas (lignite)	29.93	30.96	25.45	11.66	7,124	30.6	0.32	....	11.81

TABLE III—OPERATING RECORDS OF NATURAL-DRAFT TRAVELING STOKERS

Name of Coal	Per Cent Moisture	Per Cent Ash	Per Cent Volatile	Per Cent Fixed Carbon	Per Cent Sulphur	B.t.u. per Lb. Commercial Basis	Average Rating Per Cent	Maximum Rating Per Cent	Banked Boiler Hr. %	Economizers	Comb. Eff. of Steam Gen. Unit %	Time Covered
Illinois	14.5	16	....	....	4	10,000	...	...	30	50%	69.4	3 mo.
Kansas	4.66	11.7	33.05	50.62	4.2	10,561	...	...	..	No	69.4	24 mo.
Iowa	16.51	18.72	....	....	....	8,891	180	...	32	No	73	12 mo.
Indiana	9.8	17.7	33.3	49	4.2	10,000	170	230	30	No	70	12 mo.
Indiana	18	12.2	35.2	52.6	2.20	10,150	140	...	..	No	71	12 mo.
Pennsylvania	2.09	10.5	33.7	55.8	1.60	13,250	107	...	..	No	69.4	12 mo.
Colorado	23	12.5	32.5	32	0.20	8,865	...	...	..	Yes	72	1 mo.
Kansas	6	19	27	48	....	10,700	130	200	49	50%	69	1 mo.
Ohio & Pennsylvania	....	....	....	....	....	11,766	145	225	6	Yes	73.8	5 mo.
Iowa	15.43	21.24	....	....	....	8,593	165	220	50	No	71	12 mo.

Losses Due to the Feed Water

By A. F. Sheehan

THERE are various small losses that are not considered serious in some plants, but if the power units and steam generating equipment are heavily loaded, the cumulative effect of these losses is tremendous. The power superintendent of a large refrigerating plant in this state compiled a few figures illustrating this point for the guidance of the operator and firemen. While most plants consider a 100-deg. drop in feed temperature, which may occur due to heater failure, as involving only 9 per cent fuel loss, he proved that if such failure of feed heating equipment occurred on peak loads, the loss was over three times the theoretical amount.

The furnace had to supply the 9 per cent difference in extra heat required to make each pound of steam. In addition, with the boiler already overloaded, the furnace and boiler efficiency in this case dropped from 70 to 65 per cent, and the steam pressure usually dropped and remained low for a long period, causing the engines to take steam at a later cutoff, resulting in a 10 per cent increase in steam flow, still further aggravating the overload condition and lowering boiler efficiency.

By his figures each thousand pounds of coal burned normally was increased as follows:

$$\frac{1{,}000 \times 1.09 \times 0.70 \times 1.10}{0.65} = 1{,}285,$$

or a 28.5 per cent increase in fuel consumption would follow a 100-deg. drop in feed-water temperature unless quickly remedied.

Similarly, he proved that a 10-lb. increase in the ammonia-condenser pressure was a source of considerable loss in four separate steps: The compressor requires more power owing to increased head pressure; the load on the prime mover is further increased because of lower volumetric efficiency at the compressors; the steam rate of the prime mover increases rapidly when already loaded beyond the economical point, and the boilers are finally overloaded and operate at reduced efficiency.

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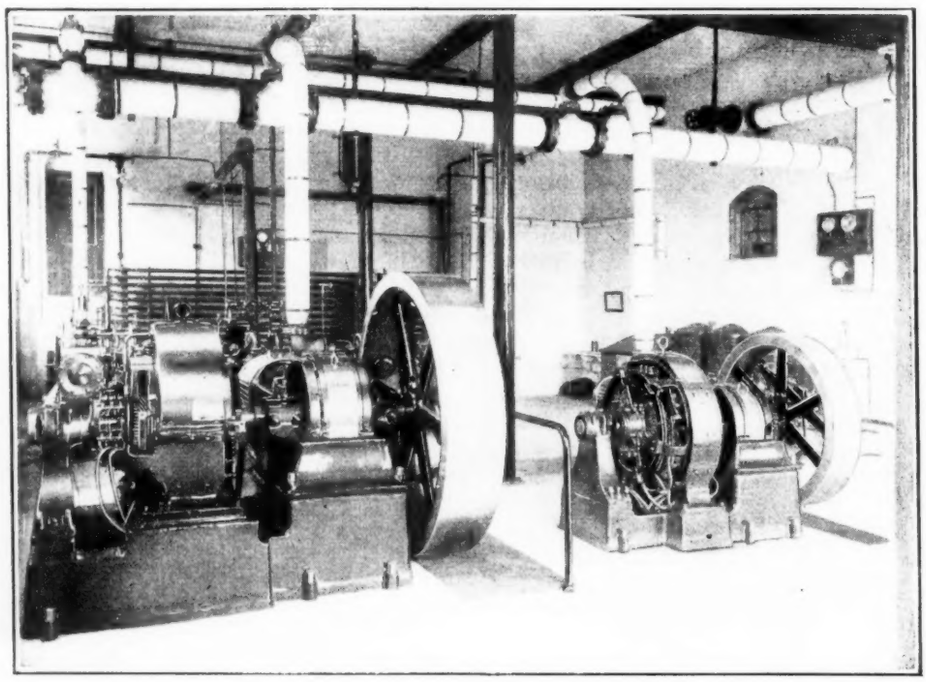

Parallel Operation of
Compound Generators

By Hendley N. Blackmon
General Engineer, Westinghouse Electric and Manufacturing Company

COMPOUND machines combine both the characteristics of the shunt and the series machines. When self-excited, the shunt field remains fairly constant, varying directly as the voltage across the armature terminals. The series excitation depends on the load amperes, but the flux produced is not directly proportional to the flow of current.

Fig. 1 is a diagrammatic sketch of a compound machine. The assumed regulation curve for this machine is shown in Fig. 2. By shunting the series field with a low resistance *D*, as shown, a portion of the total armature current will be diverted. The amperes passing through resistance *D* produce no ampere-turns for field exciting purposes. Therefore the degree of compounding may be controlled.

The characteristic curve, Fig. 2, has been assumed to produce flat-compounded conditions; that is, the no-load voltage, due to the excitation of the shunt field only, is the same as rated load voltage, which is established by the cumulative action of both shunt and series field. The voltage regulation curve of a large non-compensated generator usually rises most rapidly at the no-load end; that is, the hump occurs nearest the no-load end of the curve. This is caused by armature reaction, to a large extent.

The design ratio of main-field ampere-turns to armature ampere-turns in large direct-current generators is usually such that saturation of the pole tip does not occur until about one-third load. The buck and boost effects of the armature magneto-motive force just about neutralize each other up to this point. As the load increases, additional flux sent through one-half the pole face produces saturation in that part of the magnetic circuit. A further increase of load weakens the flux at

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one pole tip, but is now ineffective toward strengthening the other field tip by a like amount. The total flux is therefore decreased. The result of this action is that with the same excitation the generator voltage decreases steadily after passing one-third load.

In flat compounded machines the series field must compensate at full load for this decrease of air-gap flux due to distortion, besides compensating for the volts drop in the windings. This additional field, to compensate for armature reaction, is superfluous until a saturated con-

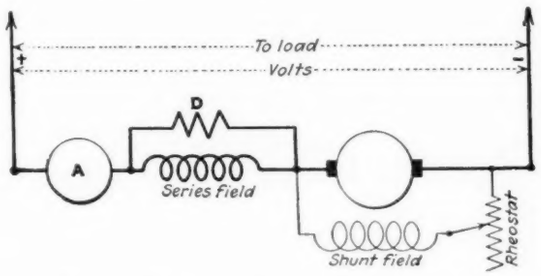

Fig. 1—Diagram of compound generator

dition of the iron is reached. For this reason the voltage rises rapidly as the first part of the load comes on and then gradually declines to the proper voltage at rated load.

In Fig. 3 it is assumed that two flat compound generators have characteristics as shown and it is desired to operate these machines in parallel. Once past the crest of the humps in the voltage curves, stable operation will be produced in the same manner as described for shunt machines in the Jan. 17 issue, page 107. The problem resolves itself into a study of conditions at loads below the peak of the voltage curves.

To magnify this portion of the characteristic a case of over-compounded machines will be considered. The machine in Fig. 1 could produce an over-compound characteristic by increasing the resistance of shunt *D*. Fig. 5 shows the voltage curves for two over-compound generators operating in parallel and each taking its rated load. Assume that for some reason, such as increased speed, generator No. 1 takes a slightly increased load. The current in the series-field winding increases and raises the operating voltage of machine No. 1 to some position *A*. This increase in voltage causes unit 1 to take more load. Since the busbar amperes are considered constant, generator No. 2 will simultaneously release some of its load, resulting in reduced voltage and a consequent further dropping of load. This action is cumulative, and unit No. 1 hogs the total load, besides driving generator No. 2 as a motor. This action explains why two compound generators, connected as in Fig. 4 are in unstable equilibrium.

In Fig. 4 the points of paralleling are the positive and negative busbars. Instead of a drooping characteristic a rising regulation exists between these points. The machines, instead of shirking load, accumulate it once equilibrium is disturbed.

The inherent regulation characteristic of the armature winding in direct-current machines is drooping. On compounded machines the external characteristic may rise with load, but this increase is caused by some external condition, such as increased field strength, and not to conditions within the armature.

If means are applied for giving a rising voltage characteristic to the machines such as series-field coils, the armature of the machines must be paralleled directly to maintain stable equilibrium. An equalizer connection is placed between the armatures of the two machines as shown in Fig. 6. Stability is caused by the internal drooping voltage characteristic of the armature winding proper and the fact that the series-field coils are paralleled at both terminals, forcing them to take proportional current at all times, thus compounding both machines equally.

Consider two machines as shown in Fig. 4. If the resistances of the series-field combinations of each machine are the same, there will be equal voltage drops across them when an equal number of amperes flow. That is, with any other value than equal currents, the drop E_1, will differ from E_2 in accordance with Ohms law, $E = IR$. Also in Fig. 4 ammeter A_1 will read the same as ammeter A_2 and the readings of meters A_3 and A_4 will check. Separate volt-ampere relations are assumed as given in Fig. 5, and the unstable operation of this connection has been pointed out.

Referring to Fig. 6, the machines are the same, but a low-resistance path or equalizer connection has been provided between the armatures. When each machine carries its proper proportion of load, no current flows

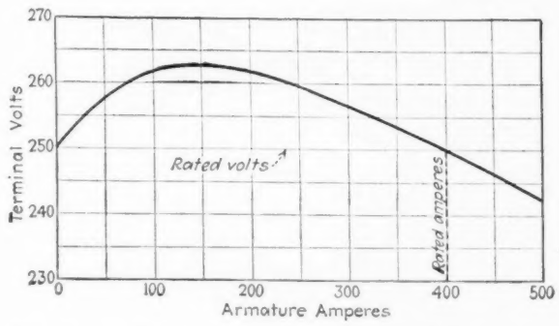

Fig. 2—Voltage curve of a compound generator

through the equalizer; that is, ammeter A_5 reads zero. This condition can be produced only when the point *M* is at the same potential as point *N*, there being no voltage to circulate current through A_5. This occurs when both units carry the same per cent load and the ratios of the resistances of the series-field circuits *NOP* and *PM* are inversely proportional to the ratings of their respective machines.

Usually, the busbar resistance *OP* is negligible, therefore only requiring the resistances *NO* and *PM* to be inversely proportional to the current ratings of the two machines. For example, if machine No. 1 was rated at

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500 amperes, 275 volts, and unit No. 2 at 1,000 amperes, 275 volts, the resistance *NOP* should be half that of *MP*. To obtain this ratio, additional resistance may be inserted in either series-field circuit, such as shown by *R*. This proportion causes the points *M* and *N* to be at the same potential when each machine carries its proportional share of the load.

Let it be assumed in Fig. 6 that both machines are

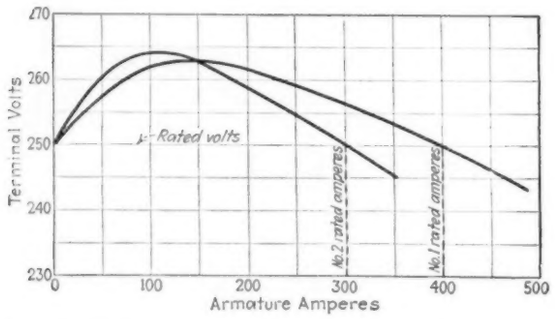

Fig. 3—Voltage curves of two compound generators having different ratings

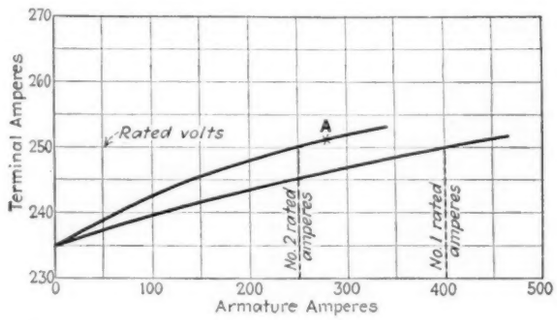

Fig. 5—Voltage curves of two over-compounded generators

carrying rated load and no current flows through the equalizer. For some reason equilibrium is disturbed and machine No. 1 momentarily increases its load. The total current increase is shown by meter A_2. The increased current, arriving at point *M*, has two parallel paths available to get to *P* and the load. It divides inversely as the resistances of the paths *MP* and *MNOP* encountered. As generator No. 1 assumed more load, generator No. 2 supplied less, since the total load remains constant. This results in a voltage difference between *M* and *N* with a consequent flow of equalizing current.

It is apparent, therefore, the meters A_2 and A_1 will not check, and similarly, meters A_3 and A_4 will show different values. The values are $A_2 = A_1 + A_5$ and $A_4 = A_3 - A_5$, where A_2 and A_4 are true armature currents of the two respective machines. Thus the series-field strength of the machine assuming more load, No. 1, is less than it would be had there been no equalizer connection, with a consequent lowering of voltage. Simultaneously, the excitation of unit No. 2, which momentarily dropped load, is automatically increased by the amount corresponding to the equalizing amperes A_5. The voltage of unit No. 1 has diminished, causing it to release load; and the potential of generator No. 2 has risen, causing it to pick up load again. This action is the same as produced by two shunt machines in parallel. The equalizer lead carries a corrective current from one machine to the other, the magnitude of the corrective force being directly proportional to the voltage between the two machines and inversely as the resistance of the equalizer.

The equalizer lead is usually the same size cable as that connecting the machines to the busbars, but as short as possible. Equalizer resistance is a question of relative resistance. To be effective, it must be low in comparison with either series-field circuit, such as from *N* to *O*.

When two over-compound generators of different capacities are to be operated in parallel, the over-compounding should increase at a rate inversely proportional to their respective current ratings. The degree of com-

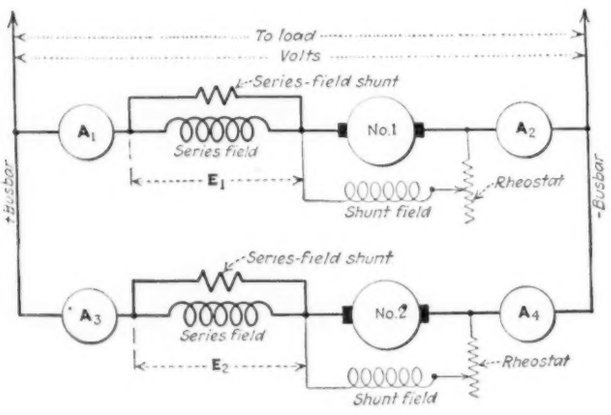

Fig. 4—Diagram of two compound generators in parallel without an equalizer

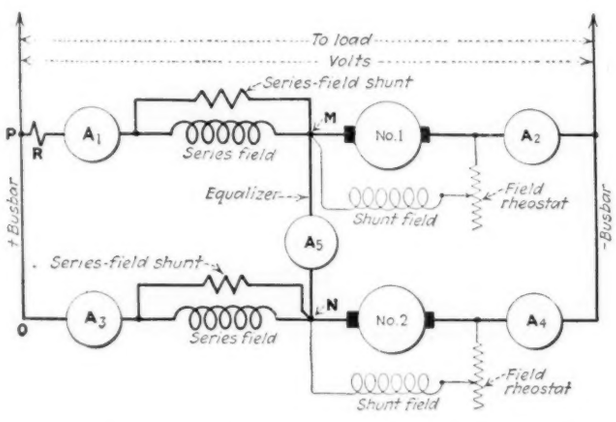

Fig. 6—Diagram of two compound generators in parallel with equalizer

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pounding for any point is the slope of the line at that point.

In Fig. 6 the series fields of two machines are connected by the equalizer for parallel operation. It is desired to lower the excitation produced by the series field of machine No. 1, in order to reduce the compounding action. A shunt placed across series field No. 1 will

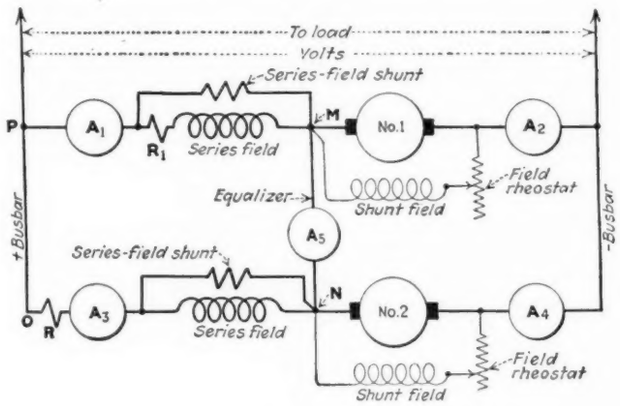


Fig. 7—Resistances R and R_1 used to adjust the load between the two machines

reduce the current through it, but the degree of compounding of machine No. 2 is also lowered. This occurs, since the series fields of machines 1 and 2 are in parallel, a shunt across one being a shunt across the other. The shunt, however, will prove more effective on No. 1 machine than on No. 2, owing to the resistance of the lead.

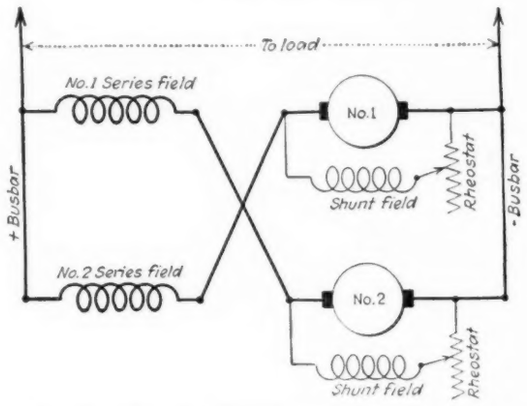


Fig. 8—Method of connecting to identical compound generators in parallel

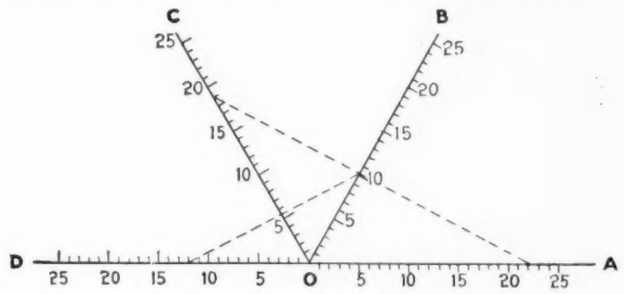
Practically all machines are actually in service with certain shunts around the series fields. Fig. 7 shows a method for lowering the compounding of one machine by placing a series resistor R_1 inside the shunt. Any alteration in No. 1 series-field circuit will necessitate rebalancing the two field-circuit resistances to maintain values inversely as the machine ratings. This may be accomplished by adjusting a resistance such as *R*.

A common case of compound-machine operation is when two machines of similar design are to be placed in parallel. Steel mill units frequently consist of a single motor in the center driving two identical generators at either end. By crossing their series fields as shown in Fig. 7, excellent corrective action is obtained. If machine No. 1 attempts to take more load, this increases the field strength of machine No. 2 and causes it to recover the load that it was dropping. The reverse action applies to unit No. 2. If it attempts to take more than its share of the load, the action increases the field strength of machine No. 1 and re-establishes the proper load division.

Chart for Solving Parallel Circuit Problems

By Elmer S. Smail

ENGINEERS frequently have the problem of calculating the total resistance of two or more electric circuits in parallel. Not that there is anything profound about it, but the formulas $R_2 = \frac{R_1 R_2}{R_1 + R_2}$ for two circuits, and $R = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \cdots}$ for more than two circuits, are not well suited for use with logarithms or the slide rule. Much labor in connection with such



Dotted lines show how chart is used

problems can be avoided by the use of the graphical method shown in the figure, and if a large scale is used the results are surprisingly accurate.

The lines *A*, *B*, *C* and *D* are divided to the desired scale of ohms, and all are 60 deg. apart around the center *O*. Suppose it is required to find the total resistance of two parallel circuits of 22 and 19 ohms each. Place a straight-edge from the 22 point on line *OA* to the 19 point on line *OC*, as indicated by the dotted line. The joint resistance will be found where this line crosses the line *OB*; that is, at 10.2 ohms.

If three circuits, as 22, 19 and 12 ohms, are involved, proceed as before except that it is unnecessary to read the value for the sum of the first two resistances on line *OB*. Instead, place the straight-edge from the point of crossing line *OB* to the 12 mark on line *OD*, and the place where line *OC* is crossed gives the joint resistance of the three circuits, or in this case 5.5 ohms.

REFRIGERATION
Equipment and Operation

Modern Ice Plant in the Southwest

By G. GROW

AT JUST what size of ice plant the law of diminishing returns begins to become evident is not known, but small plants are prosperous and their costs of ice manufacture are no more, if not less than those of large plants. Among the newer installations of moderate capacity is the oil-engine-driven plant of the Arizona Fuel & Supply Company at Tucson.

THE ice plant of the Arizona Fuel & Supply Company is of 50-ton capacity and is thoroughly modern. The prime mover is a 180-hp. Fairbanks-Morse two-stroke-cycle solid-injection Diesel engine. The engine, Fig. 1, is belted to a 10½x20-in. Vilter single-cylinder double-acting horizontal ammonia compressor and operates the plant under normal operating conditions, but to provide against any danger of shutdown, a second 10½x20-in. compressor, shown in Fig. 2, was installed, belt-driven by a 75-hp. synchronous motor.

The oil engine is also belted to a 60-kva. 440-volt three-phase 60-cycle alternator that supplies the electrical energy consumed by the motors driving the plant's auxiliaries. This generator is driven off the engine flywheel; the arrangement avoids an increase in the length of the engine's crankshaft. The exciter is belted from a pulley between the flywheel and engine bearing.

During the winter months the engine-driven compressor is, of course, too large for the ice output, so a 7x7½-in. vertical duplex single-acting compressor was installed, belted to a 30-hp. 900-r.p.m. motor.

The condensers are of the Gay continuous or "snake" type, there being six lengths of pipe in a continuous coil. These coils, of which there are eight in each of the two sets, enter vertical headers with welded joints. The condensers are placed outside the building, as shown in Fig. 4, with the headers and receiver placed in the adjoining pumphouse. In this house is a motor-driven head of a Bryon-Jackson 3-in. six-stage pump whose propellers are placed 94 ft. below the surface. The water level, when the pump is idle, is 32 ft. below the ground level.

The water for the condensers, after passing over a

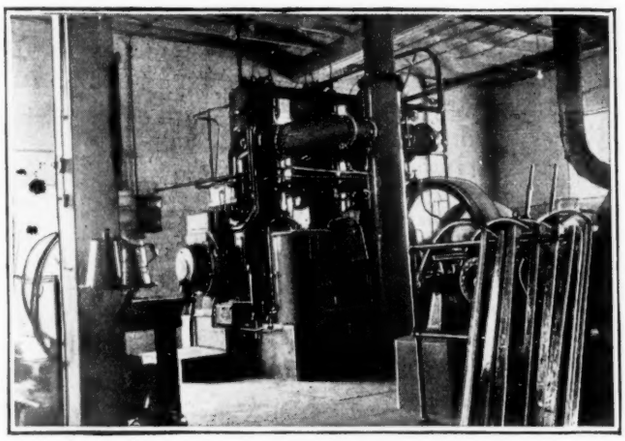


Fig. 1—The 180-hp. Diesel in the plant

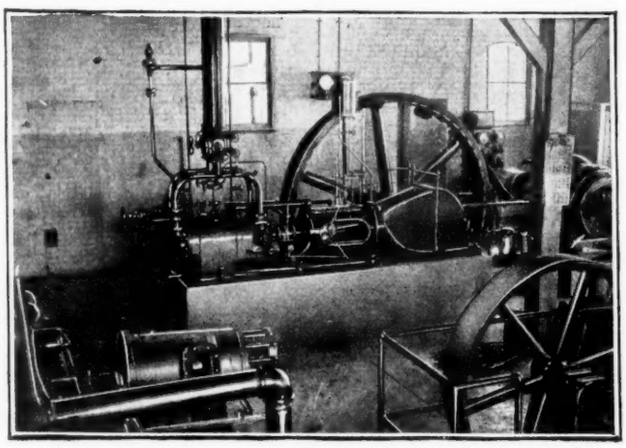


Fig. 2—A motor-driven compressor is used as a stand-by

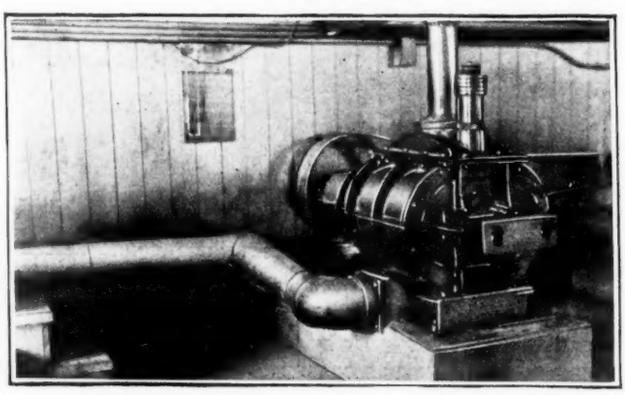


Fig. 3—A rotary blower supplies the agitation air

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cooling tower, is distributed by galvanized troughs and, after dropping down over the coils, enters a concrete sump from which it is lifted by a 3-in. Fairbanks-Morse single-stage centrifugal pump to the tower. The cooling water from the oil-engine jackets is kept separate from the condenser water, the two towers standing side by side. A 2-in. pump driven by a 2-hp. 1,800-r.p.m. motor handles this water from the sump, through the engine and back to the cooling tower.

The cooling water temperature varies with the season, and the drop as it passes down the tower ranges from 8 to 10 deg. F. As most of this cooling is due to evaporation, the makeup is large.

The average summer and fall head pressure is 135 lb. gage, and save when the plant is forced, the suction pressure is from 30 to 32 lb. gage.

The water for the cans is put through an International filter, where it is treated with sodium alumite No. 2. The filter has a capacity of 18,000 gal. before it becomes necessary to reverse the flow and recharge. Usually, the water treatment continues for eighteen hours, or at the rate of 1,000 gal. per hour.

The ice tank was built to accommodate 384 cans, but with the addition it now holds 576 cans each 11x22x46-in., giving cakes of 300 lb. The coils are run between the cans and are of the flooded design. In this system the coils are completely filled with ammonia and the suction vapor enters an overhead horizontal manifold through which the liquid to the liquid header passes in a spiral coil. This permits the evaporating liquid in the suction gas to cool the incoming liquid ammonia. An oil separator is connected to this suction header.

The brine used is a sodium-chloride solution of 16 deg. Baumé strength. The tank is provided with a lengthwise vertical baffle to insure the proper circulation of the brine. The velocity is maintained at so high a value that the difference in brine level at the tank ends is three inches. This is accommodated by raising part of the cans by this amount.

The freezing time is usually 44 hours, and the cans are then pulled in gangs of four by a Shepherd motor-driven hoist. The Monticello low-pressure air agitator system is used. The air is taken from the space between the cans and the tank top. As this air is close to 32

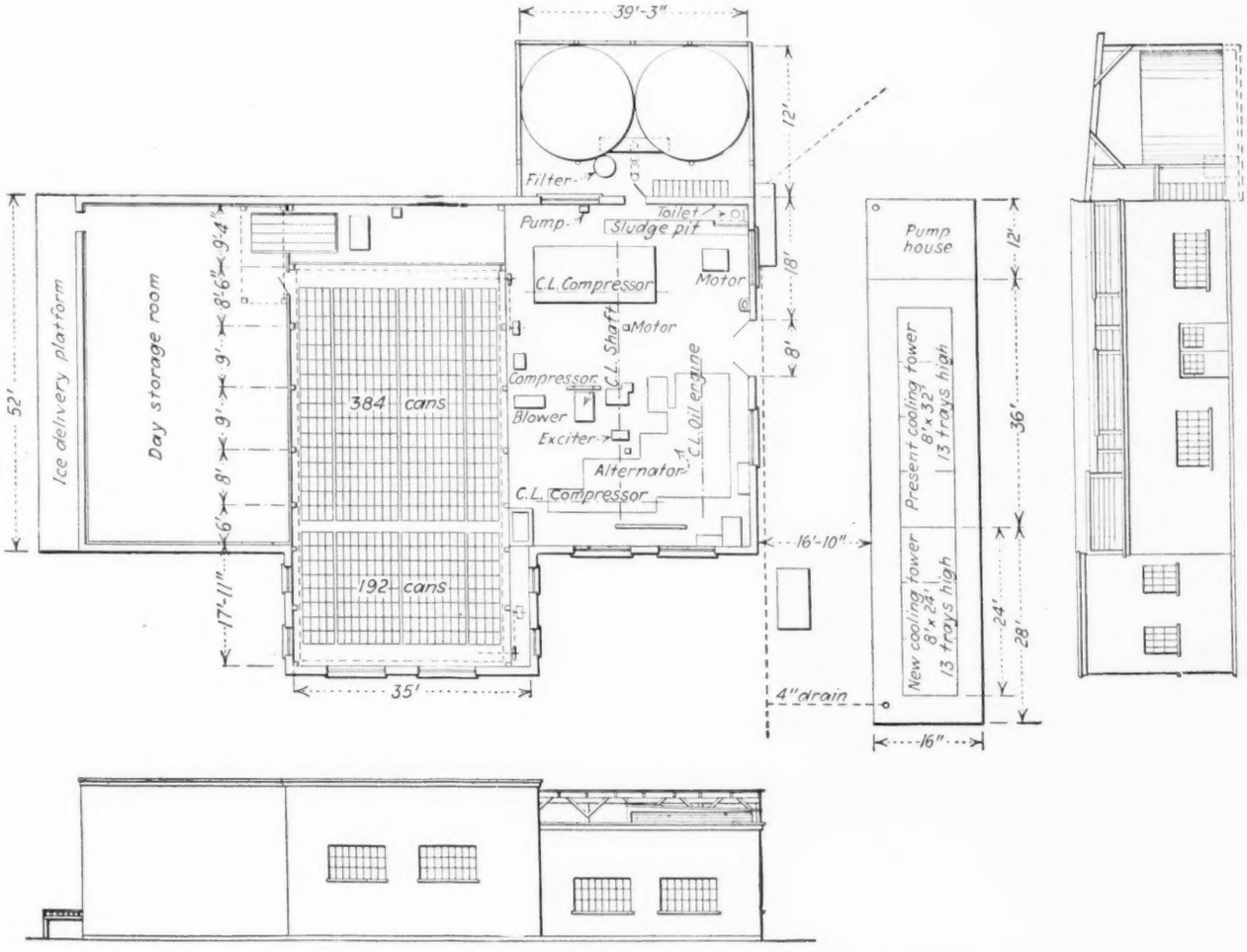

Fig. 4—Plan of the Arizona Fuel & Supply Company's ice plant

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deg. F., the amount of entrained moisture is so small that a dehumidifier is unnecessary. The air, after being raised to 2¼ lb. gage by a Wilbraham-Green 9x17 rotary blower, passes to the tank air main and then enters the cans through lateral pipes and vertical tubes. The blower, Fig. 3, is belt driven from a 7.5-hp. 870-r.p.m. Westinghouse motor.

The ice, after leaving the dump, is placed in the day storage room, where it is scored by a Gifford-Woods scorer. To have a supply of scored ice handy to the dock, a 12x12-ft. ice room is placed on the platform.

The fuel consumption per ton of ice manufactured is typical of oil-engine plants of this capacity, the year's average being 4½ gal. per ton of ice. The plant force consists of an engineer and a tank man per shift, and the engineer does all maintenance work about the plant.

Being in a residential section of Tucson, noise, of course, must be absent, so it was found necessary to build a large concrete pit into which the Diesel could exhaust. With this arrangement the exhaust cannot be detected beyond 50 ft. from the building and air vibration is totally absent.

Corrosion In Refrigerating Plants*

THE following recommendations for retarding corrosion in refrigerating plants have resulted from actual tests conducted in a large number of plants of various types. They are thought to be sufficiently comprehensive to meet almost any situation which may occur in the range of their applicability.

For calcium chloride brine in closed systems it is recommended that 100 lb. of sodium dichromate ($Na_2Cr_2O_7 2H_2O$) per thousand cubic feet of brine be added. In addition, there should be added sufficient caustic soda to convert the dichromate to the neutral chromate. For neutral brines this amount is 27 lb. per hundred pounds of dichromate; for ammoniacal brines the amount will, of course, be less and in some cases where the brine shows red with phenolphthalein after the dichromate is added, none will be needed.

The dichromate may be hung in a bag in the brine at a point of rapid circulation, or, when convenient, it is better to dissolve the retarder in a little warm water and pour the solution slowly into the circulating brine. The bag method has the advantage of requiring less labor and insuring better distribution.

In making a new tank of brine, it is recommended that the brine be mixed in a separate tank, dichromate with no caustic added, and the whole be allowed to stand until the insoluble portion settles. After this is done, the clear brine may be pumped off into the new tank, cooled to the usual temperature, and not until then should the cans be placed in the brine. By following this procedure the abnormally high initial corrosion of the galvanizing on the cans can be largely eliminated.

*Recommendations submitted to the American Society of Refrigerating Engineers by the Technical Staff at Massachusetts Institute of Technology.

For calcium-magnesium brines the same procedure recommended should be followed, except that 200 lb. of dichromate per thousand cubic feet of brine should be used. The method of making up the new brine is especially advisable.

For sodium chloride brine in closed systems, the use of sodium dichromate in the concentration of 200 lb. per thousand cubic feet of brine is recommended. The method of treatment as used for calcium chloride brine is applicable in the case of sodium chloride brine.

Open Brine Systems

The use of sodium dichromate in open systems cannot be as strongly recommended as in the case of the closed systems, on account of the possible danger from "chrome itch." A number of satisfactory plant applications have been made which indicated that when the recommended concentration of dichromate is not exceeded, little trouble of this character occurs. Dichromate can safely be recommended so far as protection is concerned, and this committee gives instructions for sanitary precautions to be observed when it is used, but the responsibility for any treatment lies with the individual plant. The observance of the strictest cleanliness cannot be too strongly emphasized. In open systems the concentration of dichromate used should be the same as that for closed systems.

For sodium brines in open systems, the use of disodium phosphate ($Na_2HPO_4 \cdot 12H_2O$) is recommended. The proper concentration to use is 100 lb. per thousand cubic feet of brine, and should be renewed once each month. The brine must be kept neutral, or very slightly acid by the addition of muriatic acid if necessary. If phenolphthalein is used to test the brine and a pink color is observed, the acid should be added until the color disappears. If the universal indicator is used, the color should be yellow. The retarder should be dissolved in hot water and added slowly to the brine at a point in front of the agitators.

Condenser Systems

The use of sodium silicate, or water glass, is recommended for condenser systems using fresh water without recirculation. No universal rule can be given for the amount to use, due to variations in local conditions. In general 1.5 gal. of 40 deg. Bé. silicate per day per thousand cubic feet of makeup water should be used at first. This amount should cause the water to show pink to phenolphthalein after one hour, and if this coloration is not obtained at the end of one week's application, the additions should be increased.

Sodium dichromate is recommended for recirculating condenser systems which use water containing salt. The recommended concentration is 6.5 lb. per thousand cubic feet of makeup water. Caustic soda equal to 1.7 lb. per thousand cubic feet should also be added.

It is recommended that condensers be kept free from slime and scale at all times, especially during the summer months. The formation of a coating on the pipes raises power costs considerably, and, it seems safe to say that, in the average plant, the condensers are cleaned far too seldom. Efficient water distribution is equally important in obtaining efficient heat transfer.

Operating Experience with High Pressure and High Temperature Steam

[*Presented at the Mid-West Power Conference Chicago, Feb. 16*]

By G. A. Orrok

Consulting Engineer The New York Edison Company

FIVE years ago, in a paper on the "Commercial Possibilities of High Pressure and High Superheat in the Central Station," I examined the effect, on the boiler, piping, valves and turbines, of the increasing values of pressure and temperatures, then contemplated by many designers and operators of central stations. I concluded that pressures of 1,200 to 1,500 lb. were commercial and could be used with little difficulty, but the temperatures in excess of 750 deg. might offer difficulties if ordinary materials were used.

Since then many high-pressure boilers, with their attendant piping and turbines or engines, have been installed and operated for varying periods up to the five years that have now become history since that paper was written.

At that time (1922) the only really high-pressure boiler in use was the experimental boiler of Schmidt and Hartmann, which had been operating for 14,000 hours at between 700 and 900 lb. pressure and giving little trouble. Blomquist, in Sweden, had been working his revolving-tube boiler with good success and had installed two boilers at about 1,000 lb. pressure in two industrial establishments. North Tees was running at 450 lb., the Joliet station at 400 lb. had been put in service the year before and Gennevilliers also at 400 lb. was running, but going through the breaking-in period.

I have endeavored to collect the particulars of all the high-pressure installations in operation or under construction at the present time and these data are given in the table. With the wealth and variety of material shown in this table, some of which extends over 20,000 hours of use, it would appear useful to collect the operating experiences and see how nearly the conclusions of 1922 have been justified by the facts in the case. To do this the reports of the Prime Movers Committee of the N.E.L.A. and the proceedings of the Union Internationale des Producteurs et Distributeurs d'Energie Electrique and the various operating papers before our American Engineering Societies have been examined, and this body of facts has been supplemented by personal letters from many of my friends in charge of high-pressure installations.

All reports agree on one fact which recurs with remarkable regularity in these reports: Operating troubles are no greater with high pressures than with the ordinary 200-lb. pressure so long standard. There seems to be no difficulty in handling high-pressure steam with apparatus of the conventional type made proportionately heavy. No more troubles with our 750-lb. plant than with our 300-lb. plant. Troubles with the conveyors and feed pumps, but not with the boiler. No trouble with the boiler, but the type of gage glass used has had to be changed. Trouble with economizer section, but not with the boiler. It thus seems to be established that of the many high-pressure installations, no operator has encountered difficulties due to the high pressure, while some report an increase in steadiness of action.

Results Justify Use of High Pressures

Without exception all operators agree that the installation of the high pressure they use has been justified by results, thermal and commercial, and a number are installing more machinery of the same kind. These repeat orders have been given in base-load plants, in bleeder or high-pressure plants exhausting into process or low-pressure mains, where the turbine acts as a reducing valve, and also in stations without base load, as at Langerbrugge and Charlottenburg. It would thus appear that in these conditions the extra first cost of the high-pressure apparatus was not very large, and, quite possibly, of the order suggested in my 1922 paper.

The range of fuel cost runs from $2.50 to over $8 per ton in the various plants, but apparently makes little difference in the commercial aspect of the case, since they all report commercial savings.

It is interesting to note the places where troubles were expected but did not develop: It was first thought that safety valves might give trouble and pilot safety valves were fitted to blow at a lower pressure. Experience has shown that these valves are as reliable as those operating at a much lower pressure, and the pilot valves have been removed. Difficulties were expected with the water level in drums when load changes occurred. These difficulties have not manifested themselves except in a minor way and are not nearly so noticeable as in lower-pressure boilers. Troubles were expected from the expanded joints between tube and drum. These troubles have not developed. Superheater and reheater troubles were looked for, but have been no more prevalent than in other installations. The large amount of energy in the re-

Data on High Pressure Boiler Installations

Location		Boiler							Superheater		Reheater			Econ-omizer	Air Preheater		Prime Mover			
Plant	Place	Type	Make	Abs. Pressure Lbs. Per Sq.In.	Surface, Sq.Ft.	Firing	Furnace Wall Type	Furnace Wall Area, Sq.Ft.	Surface, Sq.Ft.	Total Temp., Deg. F.	Type	Surface, Sq.Ft.	Total Temp., Deg. F.	Surface, Sq.Ft.	Type	Surface, Sq.Ft.	Make	K. W.	Speed, R.P.M.	Barrels
Klingenberg	Berlin	Stirling cross drum	Borsig B. & W.	515	17,200	Pulv.	Water	1,615	10,200 6,840	750	.....	.....	.....	7,930	Tube Plate	19,900	A.E.G.	85,000	1,500	4
Charlottenburg	Germany	Cross drum	Borsig B. & W.	515	7,500	Stoker	Refract.	....	.....	800	.....	.....	.....	5,320	.....	.....	Zoelly	6,400	3,000	3
Aarau	Switzerland	Inclined	B. B.	515	3,770	Stoker	Refract.	....	.....	755	.....	.....	.....	.....	.....	.....	B. B.	380	5,000	1
S. S. King George V	Scotland	Yarrow	Yarrow	565	3,400	Hand	Refract.	....	870	750	.....	.....	.....	.....	Tube	2,200	Parsons	2,600	6,000	3
Columbia	Cincinnati	Cross drum	B. & W.	615	15,110	Pulv.	Air	....	2,760 3,184	750	.....	.....	.....	7,300	Tube	39,889	G. E.	45,000	1,800	2
Columbia	Cincinnati	Cross drum reheat	B. & W.	615	6,066	Pulv.	Air	....	1,410	750	Convec.	17,612	725	.....	Tube	9,889	.....	.....	.....	..
Crawford	Chicago	Cross drum	B. & W.	615	16,615	Stoker	Air	788	2,700	750	.....	.....	.....	11,054	Tube	10,000	G. E.	50,000	1,800	2
							Water	2,515	3,100		.....	.....	.....	7,376	Plate	15,913	West Parsons	60,000 75,000		3
Crawford	Chicago	Cross drum reheat	B. & W.	615	6,007	Stoker	.....	....	1,443	750	Convec. Steam	17,458 16,124	700	7,500	.....	.....	.....	104,000 91,500	.....	..
Philo	Philo, Ohio	Cross drum	B. & W.	615	14,086	Stoker	Refract.	....	2,485	725	.....	.....	.....	8,837	Plate	9,700	G. E.	40,000 160,000	1,800	1 3
Philo	Philo, Ohio	Cross drum reheat	B. & W.	615	5,031	Stoker	Refract.	....	1,632	725	Convec.	11,158	725	8,837	Plate	9,700	.....	.....	.....	..
Twin Branch	South Bend, Ind.	Cross drum	B. & W.	615	14,086	Stoker	Refract.	....	2,485	725	.....	.....	.....	8,837	Plate	9,700	G. E.	40,000	1,800	1
Twin Branch	South Bend, Ind.	Cross drum reheat	B. & W.	615	5,031	Stoker	Refract.	....	1,632	725	Convec.	11,158	725	8,837	Plate	9,700	.....	.....	.....	..
Stanton	Pittston, Pa.	Cross drum	B. & W.	665	17,962	Stoker	Refract.	....	2,800	750	.....	.....	.....	3,011	Ro- tary	81,000	G. E.	45,000	1,800	1
Stanton	Pittston, Pa.	Cross drum reheat	B. & W.	665	5,978	Stoker	Refract.	....	1,600	740	Convec.	13,481	730	3,011	Ro- tary	81,000	.....	.....	.....	..
State Line	Hammond, Ind.	.....	B. & W.	615	.....	Pulv.	Bailey	....	.....	730	Steam	.....	500	.....	.....	.....	G. E.	208,000	1,800	3
Waukegan	Waukegan, Ill.	.....	B. & W.	615	.....	.....	.....	.....	.....	728	.....	.....	.....	.....	.....	.....	A. C.	50,000	1,800	2
Issy-Sur-Moulineaux	France	Stirling	Cie De Fives	615	19,450	Pulv.	Water	1,710	.....	842	.....	.....	.....	.....	Plate	29,500	Cie Alsacienne Rateau	11,000	3,000	1
Ludwigshafen	Germany	.....	.....	615	.....	.....	.....	.....	.....	.....	.....	.....	.....	[7]	.....	.....	.....	.....	.....	..
Amsterdam	Holland	.....	Clayton	635	14,400	Pulv.	.....	.....	.....	710	.....	.....	.....	.....	.....	.....	.....	.....	.....	..
C. H. A. D. E.	Buenos Aires	Cross drum	B. & W.	665	15,400	Pulv.	Water	1,775	.....	750	.....	.....	.....	.....	Plate	.....	G. E.	35,000	.....	1
C. H. A. D. E.	Buenos Aires	Cross drum reheat	B. & W.	665	4,780	Pulv.	Water	1,775	.....	750	Convec.	.....	.....	.....	Plate	.....	.....	.....	.....	..
Berlin Brewery	Berlin	Schmidt	Borsig	705	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	..
Langerbrugge	Belgium	Marine cross drum	B. & W.	765	4,765	Stoker	Refract.	....	1,172	842	.....	.....	.....	.....	Tube	4,900	B. B.	1,750	8,000	2
Goeteborg	Sweden	Rotating tube	Atmos.	815	150	Stoker	Refract.	....	.....	.....	.....	.....	.....	2,500	.....	.....	De Laval	.....	6,000	..
Solvay	Syracuse, N. Y.	Steam generator	C. E.	840	6,772	Pulv.	.....	....	3,700	735	.....	.....	.....	4,480	Plate	23,400	W.	5,000	3,600	1
Tegel	Germany	Schmidt	Borsig	863	3,230	Stoker	Refract.	....	1,465	797	.....	.....	.....	2,180	.....	.....	.....	.....	120	..
Valley Road	Bradford, Eng.	Marine cross drum	B. & W.	865	.....	Stoker	Water	....	.....	800	.....	.....	.....	.....	.....	.....	E. E.	2,500	6,000	1
Hanover	Germany	Vertical	Schmidt	880	.....	Pulv.	.....	....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	..
Wernigerode	Germany	S. H. G.	Schmidt	882	1,420	Hand	Refract.	....	.....	860	.....	.....	.....	210	.....	.....	.....	.....	.....	..
Wernigerode	Germany	Vertical	Schmidt	885	775	Hand	Refract.	....	247	.....	.....	.....	.....	210	.....	.....	.....	.....	.....	..
Aussig Chemical			B. & W.	1,015	.....	.....	.....	.....	.....	547	.....	.....	.....	.....	.....	.....	.....	.....	.....	..
Egyptain Salt and Soda	Egypt	.....	B. & W.	1,115	.....	.....	.....	.....	.....	547	.....	.....	.....	.....	.....	.....	.....	.....	.....	..
Ludwigshafen	Germany	.....	Hartmann	1,115	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	..
Manning, Maxwell & Moore	Bridgeport, Conn.	Cross drum	B. & W.	1,215	.....	Stoker	.....	.....	.....	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	..
Mason Fibre Co.	Laurel, Miss.	Cross drum	B. & W.	1,215	4,000	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	..
Lakeside	Milwaukee	Stirling reheat	B. & W.	1,265	28,532	Pulv.	Water	1,544	930	730	Radiant	933	720	.....	Plate	20,160	G. E.	7,500	3,600	1
Edgar	Boston	Cross drum reheat	B. & W.	1,215	15,732	Stoker	Bailey	....	2,923	707	Convec.	5,938	701	5,596	Tube	32,032	G. E.	3,150	3,600	1
				1,415	15,093					725			750					10,000		
North East	Kansas City	Ladd	C. E.	1,415	16,950	Pulv.	Water	3,295	.....	725	Radiant	.....	700	9,432	Plate	39,270	W.	10,000	3,600	1
Mannheim	Germany	Stirling	.....	1,415	.....	.....	.....	.....	.....	810	.....	.....	.....	.....	.....	.....	B. B.	.....	3,000	..
Winterhur	Switzerland	Garbe	Sulzer	1,440	500	Pulv.	Air	....	430	707	.....	.....	.....	1,240	Plate	1,940	.....	.....	.....	..
							Refract.		86											
Stockholm	Sweden	Rotating tube	Atmos.	1,515	.....	Stoker	Refract.	....	.....	.....	.....	.....	.....	.....	.....	.....	De Laval	.....	.....	2
Witkowitz	Austria	Coil	Loeffler	1,515	.....	Oil	.....	....	.....	843	.....	.....	752	.....	.....	.....	Erste-Brunner	18,000	.....	..
Florisdorf	Austria	Coil	Loeffler	1,770	.....	Pulv.	.....	....	.....	896	.....	.....	.....	.....	.....	.....	.....	1,000	.....	..
English Electric Co.	Rugby	Coil	Benson	3,200	.....	Oil	Refract.	....	.....	662	.....	.....	.....	.....	Plate	.....	E. E.	360	25,000	1
Siemenstaadt	Berlin	Bent tube	Benson	3,200	2,329	Oil	Refract.	....	1,420	752	.....	.....	.....	3,280	Plate	.....	Escher-Wyss	1,000	10,000	1
Siemenstaadt	Berlin	Coil	Benson	3,200	4,000	Pulv.	Water	.....	.....	790	Convec.	.....	824	.....	Plate	.....	Escher-Wyss	3,200	.....	2
Vitry	France	Ladd	Delauney Belleville	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	..
Cassel	Germany	.....	Schmidt	....	.....	.....	.....	....	.....	...	.....	.....	.....	.....	.....	.....	.....	.....	.....	..

superheater piping and resuperheaters was believed to be a source of trouble, much thought and money being expended on this system. No troubles of serious nature have been reported from this source. Piping and valve difficulties were believed to be incidental to high-pressure work, but very few troubles have been reported, the smaller sizes used with the high-pressure steam have avoided this difficulty.

Unexpected Troubles Have Developed

Unexpected troubles of various kinds have developed and have been overcome in the same way as when, in earlier days, similar troubles were corrected in boilers working under ordinary pressures. Handhole gasket troubles have been reported from a number of sources. This sort of trouble has always been with us and is soon eliminated. Feed-pump troubles have developed in most every plant and have been corrected, but not as easily as the gasket trouble. Feed-water regulators have given some trouble, but were soon put right. Gage-glass troubles have been reported from nearly all plants. These troubles have ceased when heavier and better-designed fittings have been provided. Some trouble has been experienced from the leaking of cast-steel fittings, but this can be as readily overcome as when 200 lb. pressure was the standard.

A number of operators have reported that finely powdered solids have been carried over with the steam into the turbine, where it has made the usual trouble by deposition in nozzles and erosion of blades. Just how this material is carried is not known, but when the concentration of the boiler water is reduced to the proper point, this difficulty should disappear.

No Unusual Turbine Difficulties

Turbine difficulties have been of the usual character. Vibration, much smaller in extent and much less destructive than in the larger units, has been the main trouble with European designs. Gland troubles have been reported, but slight changes in type of gland removed this difficulty. No troubles have been reported that could definitely be laid to high pressures, except certain heat deformations of nozzles due to unexpectedly high superheat at Gennevilliers. The machines for a higher pressure than 600 lb. are all small and quite sturdy, 10,000 kw. being the largest unit yet built. The liability to trouble is small indeed. A number of operators report a slight oxidation of turbine blades and nozzles as well as the inside surfaces of the casings exposed to the high-pressure steam. The phenomenon appears to be similar to the thin reddish brown oxide found in the interior of our high-pressure superheated steam pipes. This scale is thin, hard and intensely adherent. Apparently, it does not thicken with time of exposure, but acts as a protective coating. From the reports we may conclude that there are no serious difficulties in the operation of turbines at pressures between 1,200 and 2,000 lb. per square inch.

We have one installation using high pressure where the superheat temperature has been higher than the customary 700 deg. to 750 deg. F. This is the Langerbrugge Station of the Centrales Electriques des Flanders, where the standard superheat temperature is 850 deg. F. The station had been using this temperature over two years when I had the opportunity of examining one of the superheaters, and has now been running about four years. On my examination in August, 1926, the condition of the superheaters presented nothing out of the ordinary. Indeed, they might have been running at 650 deg.-700 deg. F. and were similar in appearance to the lower pressure and temperature superheater now running in our older stations. Several other plants have reported sporadic temperatures of 800 deg. to 1,000 deg. F. for a few hours without serious consequences. A number of operators report replacing a few superheater coils, but the replacement was not due to high temperature or pressure and is not more common than in the 200 lb. to 500 lb. plants.

Turbines and piping and valves used for high pressure have not departed materially in design from the lower pressure standards. Where higher temperatures than the usual 700 deg. to 750 deg. F. are concerned, the expansion problem must be more carefully considered. Very probably up to 800 to 850 deg. F. the usual qualities of steel will perform satisfactorily, but some operators report the use of alloy steels for shells, tubes and castings. Riveted drums have not been used above 650 lb. except at Langerbrugge, where some trouble has occurred from leaks. It has been stated that these drums are to be replaced with welded or forged drums. All of the remainder of the high-pressure jobs use forged or welded drums or else no drums at all. Such boilers as the Benson and Atmos only require collectors, while in the Hartmann and Loeffler boilers the drum is away from the fire and the heating is internal through the agency of superheated steam.

Conclusions

1. There appear to be no serious difficulties in the operation of plants using pressures ranging up to at least 2,000 lb. per square inch.

2. Four years' experience in continuous operation of superheaters raising the steam temperatures to 850 deg. F. with ordinary steel superheater tubes has proved such operation commercial, as no serious difficulties have been encountered.

3. Alloy steels for tubes, shells and castings are available for more difficult operating conditions than have been heretofore tried out in practice. Boiler companies state they are ready to guarantee service to 900 deg. F.

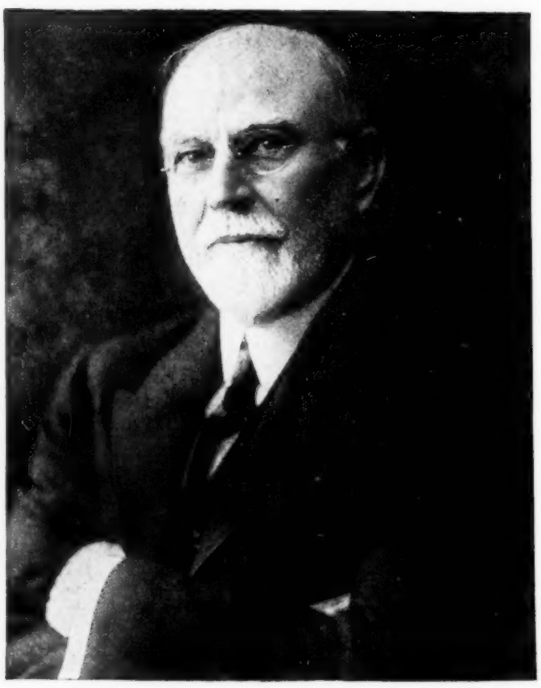
4. Operators report both thermal and commercial economy in the use of higher pressures, and this is evidenced by repeat orders for similar apparatus.

5. Commercial results have not been reported quantitatively, and we are no nearer an answer as to the most economical pressure and temperature to use for any given case.

The Type of an Electric Welding Arc may be changed by the chemical and structural variations in the surface materials of welding electrodes. Four types of arcs being recognized are the steady core, erratic core, sheath type, and saturated arc. A saturated arc is probably the most satisfactory arc for the welder to handle. Surface materials also have a significant influence on the ductility of weld metal and on its freedom from blowholes. These and other practical applications of a comprehensive knowledge of surface materials are cited in a paper by J. B. Green on "Metallic Arc Welding Electrodes," presented at the Winter Conference of the A.I.E.E.

James H. McGraw Awarded

Honor for Distinguished Services to Field Given to Publisher of POWER



AT A dinner in Boston on Friday, Feb. 17, James H. McGraw, president of the McGraw-Hill Publishing Company, Inc., publishers of *Power*, was presented with the Harvard Advertising Award for Distinguished Services to Advertising by the Graduate School of Business Administration, Harvard University.

The award is one of ten founded by Edward Bok and administered by the Graduate School of Business Administration of Harvard University to encourage merit and stimulate improvement in advertising. The other nine are for the best advertising campaigns, the best scientific research in advertising and the best individual advertisements. The award made to Mr. McGraw is given to "the individual or organization deemed by the Jury of Award to merit recognition for contemporary services to advertising." It consists of a gold medal, bearing the inscription: "To James H. McGraw—For distinguished personal service rendered American commerce and industry through raising the standards of advertising—1927."

Mr. McGraw is the third person to be honored with the medal for distinguished services to advertising. The other recipients have been Ernest E. Calkins, of Calkins & Holden, and O. C. Harn, of the Audit Bureau of Circulations.

James H. McGraw is president of the McGraw-Hill Publishing Company—the largest business publishing organization in the world. It has grown from one paper, purchased by Mr. McGraw in 1888, until today there are published fourteen engineering and industrial publications—twelve in New York, one in San Francisco, and one in London. Mr. McGraw is chairman of the McGraw-Shaw Company, publishers of industrial papers in Chicago. He is also chairman of the McGraw-Hill Book Company, leading publishers of technical and business books.

The weekly and monthly journals over which Mr. McGraw exercises executive control penetrate to every civilized country. They cover the fields of civil engineering and heavy engineering construction; the electrical, radio, electric railway and bus industries; the machine-using industries; the generation and application of power; the chemical industries, coal mining, and non-ferrous metal mining. McGraw-Shaw publications serve industrial management and plant engineering through the broad sweep of industry as a whole. In the electrical and the electric railway industries Mr. McGraw has pioneered in development from the early days when electrical manufacturing consisted of an unrelated and scattered group of small shops and manufactories.

His publications have been responsible for the adoption of co-operative movements in many industries. They have insisted upon the elimination of unethical practices, wasteful of the public good. Industry is today served by over one hundred full-time McGraw-Hill editors.

Mr. McGraw has been a pioneer in the recognition of advertising's relation to marketing. Studies of industry's buying habits and the effective form of marketing organization for industrial products have done much to clarify industry's appreciation of the particular requirements of industrial marketing, as contrasted with the development of sales to the private consumer.

In the field of business publishing Mr. McGraw has been a leader in securing adoption of the code of ethics and business practice which today governs the activities of the organized business press.

Harvard Advertising Medal

The constructive services of Mr. McGraw to the upbuilding of American industry were recognized at a dinner of industrial leaders, held in New York a year ago. The committee which arranged for the dinner to Mr. McGraw included Secretary Herbert Hoover, Thomas A. Edison, Owen D. Young, the late Guy E. Tripp, Simon Guggenheim, John Hays Hammond, General William Barclay Parsons and General Swope.

Mr. McGraw was born in Panama, Chautauqua County, New York, December 17, 1860. He came into publishing from the principalship of an upstate school. He is a member of many engineering, business and scientific organizations. Among these are the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, National Electric Light Association, American Electric Railway Association, the Illuminating Engineering Society, Harvard Business Historical Society.

THE official news release given out by Harvard University states the reason for making the award to Mr. McGraw as "his lifelong service in the upbuilding of higher standards in advertising in the business press of the country." In presenting the medal, Professor Sprague spoke of Mr. McGraw's pioneering work in the recognition of advertising's relation to marketing and of his constructive services in the upbuilding of the highest advertising practices among the organized business press.

On receiving the award, Mr. McGraw said, in part: "At these milestones of advertising appraisement which Mr. Bok has so happily placed in our journey toward a larger national well-being, it is fitting that we re-examine advertising, with particular reference to the current situation.

"At present the volume of trade is large. But competition is throttling; and profits, in some quarters, are declining. Some industries are despairing of customers. Has advertising, now so generally used, proved ineffective in maintaining full prosperity? Or have we as yet failed to fully appropriate the power of this great force? Lowered profits and idle capacity are not the concern of the stockholder alone. The public as a whole—employing and employed, as well as investor—suffers a set-back when profits are squeezed and wares go a begging.

"Primarily, the function of advertising as a business force is to interpret or expand a personality, whether of a product or of a service or of an industry. Products and services vary greatly in personality or distinctiveness. And it has long been recognized that a distinctive product has a decided advantage and security in the market. Excessive competition, with the squeezing out of normal profits, results from a surplus of identical or alternate products, or a surplus of products believed to be alternate.

"Now advertising has won its spurs in the economical movement of distinctive goods, with resultant public gain. Is it not the greater field of staples or near-staples to which advertising must now be more widely applied, both in the industrial and consumer fields? And may not we here find a tonic for the price competition malady, thus aiding to restore complete industrial health?

"In considering the broader, as well as the more effective, use of advertising, it may well be questioned whether any product, however staple at first sight it may appear, is without elements of distinction. A product is endowed with the qualities of its makers, and no organization is entirely devoid of personality. The very fact of survival in a competitive market is proof that there is distinctiveness in product or service. There are such individual factors as company reliability; assurance of progressive product improvement through intelligent engineering or painstaking research; ability to assist buyers by prompt deliveries; competence of representatives to advise on use and application of the product and on the condition of the market. There are a hundred respects in which firms differ from each other. All these affect the willingness of the buyer to take one manufacturer's product rather than another's, even though the products appear to be similar.

"We must increase our knowledge of how to sense these elements of distinctiveness in this great field of the staple product. Then we shall open up new vistas of advertising effort. Then we shall transfer many products from the miasma of excessive price competition to the high free air of competition in quality and service. Then we shall trade up, rather than down. And business will be the healthier for it.

"Advertising is a challenge to soundness. It drags an institution into the limelight. It exposes it to examination and to criticism of its claims. Its defects are sure to be exposed.

"For businesses with production that matches the needs of the times, advertising is a beneficent instrument; for those with products that have no rightful market claim, advertising is either corrective or fatal.

"THROUGH the adoption of production economies, principally the greater use of power and the fruits of research, established industries constantly reduce the numbers of their employees per unit of product. The surplus workers thus thrown off by older industries must be absorbed into new ones, otherwise we shall have widespread unemployment, lowered standards of living, suffering, discontent. It is the rôle of consumer advertising quickly to introduce new products to a mass market, and thus create new demands for surplus labor.

"Advertising's place in such development of new products is clear. What would be the price situation in the shoe, the furniture, the carpet, and other staple industries if they were trying to employ the men and money which have gone into the automobile, rayon and motion picture business? New enterprises absorb surplus labor, create new purchasing power, stimulate consumer ambitions, render business profitable and make for social well-being. Advertising is the loudspeaker for development.

"For myself and my colleagues in business paper advertising, I pledge you our best endeavors in a continuance of study, research and experiment, to correct misapplication of advertising, to make it a still more effective tool of business, and a still more beneficent agent in advancing the public welfare."

EDITORIALS

Co-ordination in Research

THERE are a large number of universities in the United States well equipped to carry out fundamental researches. A considerable portion of the work done in these laboratories is of no immediate value to industry. This is to be expected, as the development of basic theory is one of the prerogatives of the university.

There exists an opportunity for these laboratories to perform research work also, the results of which industry can apply and use today. Many times all that is needed to bring this about is the suggestive influence of industry itself.

The industry of heating and ventilating, through the American Society of Heating and Ventilating Engineers, is making use of this opportunity. This society has endeavored to secure the co-operation of various universities and has co-ordinated their research work in this field along lines most needed by the industry. The degree of success attained by these efforts is reflected by the fact that one-quarter of the papers presented at the annual meeting of the Society contained reports of researches carried on in university laboratories. Thus each year this industry is profiting by the technical data that are being made available to aid in designing more efficient heating and ventilating installations.

While this use of university testing facilities is producing laudable results, it should not be practiced to such an extent that it in any way interferes with the basic researches for which the world looks to the university.

The Engineers' Side of an Indictment

A SEVERE attack on engineers was embodied in an editorial in a recent number of *The New Republic*, entitled "Price and the Engineer." While few engineers will be found in agreement with the thoughts expressed by that particular editorial writer, it is high time that those interested in the standing of the engineering profession should refute the allegations so widely broadcast in a publication appealing to the public mind.

It is by no means true that engineers have sold out to the public utility corporations, as was averred. There are those whose training, environment and appreciation of social ethics incline them to oppose any monopolistic tendencies. Others equally sincere favor the enlargement of the public utility field, honestly believing that this means increased production per man and decreased costs of both necessities and luxuries. Neither can fairly be said to have sold out to anyone, and the weight and the value of their opinions as viewed by fellow engineers, depend upon the qualifications of the advocates.

That engineers publicaly voice their belief in private operation of public conveniences should not be taken as indicative of a shady transaction. Whether he be in the employ of a corporation or not, perfect freedom of speech should be granted the engineer without danger of calumny.

The New Republic editor, obviously, was led into his misjudgment by a tendency of engineers, as in case of other professional men, to groom their private views in some sort of official toga to give them the air of authority. In the example cited, that of the American Engineering Council in declaring against the use of public funds in the construction of Boulder Dam, members of the several engineering societies having representatives on the Council, understand that the Council speaks with the voice of the authority of the affiliated societies only when it deals with engineering problems. It does not represent the societies on questions of politics and the declaration on Boulder Dam is but the opinion of the members of the Council speaking as individuals.

Unfortunately, the public does not appreciate this fact. Would it not therefore be wiser for the American Engineering Council to confine its formal pronouncements to the strictly technical aspects of public questions?

Economic Reasons Rather Than Reliability

IT IS now generally recognized that, with few exceptions, where water power is available a certain amount of steam-plant capacity is necessary if the most economical power supply is to be attained. The ratio between steam and hydro is an ever-changing quantity, and this has frequently led to misunderstanding regarding the value of water power. On the one hand, there are those that overestimate the value of water power and underestimate the steam plant, and on the other hand there are those that do the opposite and even go so far as to try to show that water power has been eliminated from the economic picture.

The latter attitude has recently been given considerable impetus by the improvements made in steam plants, the low cost of fuels, the operating difficulties experienced with long high-voltage transmission lines, the variable character of water supply on most rivers, the comparative

costs of hydro-electric plants with transmission lines and steam plants at load centers and the necessity of having a certain amount of steam-plant capacity at large metropolitan centers to insure reliability of the service.

In a paper presented before the Midwinter Convention of the American Institute of Electrical Engineers, P. M. Downing, vice-president of the Pacific Gas & Electric Company, states, "From the standpoint of continuity of service steam plants play a less important part than they did a few years ago." Several factors have contributed to bring this about, such as a greater number of hydro plants feeding into the system, a more extensive system of transmission lines, better designs of insulators and more substantially constructed lines, all of which help to make the service over such a system more dependable.

Mr. Downing further states that during 1927 climatic conditions in California were such as to afford an abundant water supply at all his company's hydro-electric plants. The steam plants in the important cities were floated on the system as a protection against interruption to service that might occur. With a peak load of 439,568 kilowatts and an energy output of 2,380,000,000 kilowatt-hours, less than nine-tenths of one per cent of the power was produced by steam plants.

There are probably few localities where an adequate power supply could be provided over long transmission lines, but the experience of Mr. Downing's company show that so far as the reliability of the system is concerned, the steam plant is probably not the important factor today that it has been pictured. This, however, does not change the situation, since economic considerations in the design and operation of the system will determine the amount of steam capacity rather than reliability. Therefore, even if overhead long-distant transmission systems were to be made one hundred per cent reliable, a certain amount of steam capacity would be required for economic reasons, if for no other.

Recognition for Technical Advertising

THE award of the Harvard advertising medal for distinguished services to advertising, recently made by the Graduate School of Business Administration, Harvard University, to James H. McGraw, publisher of *Power*, emphasizes once more the increasingly important part played in life by technical advertising.

The group of awards, of which this is one, were founded by Edward Bok, formerly active in the Curtis Publishing Company, for the purpose of encouraging merit and stimulating improvement in advertising. Of the four awards this is the only one given for general service in improving advertising, the others being for specific pieces of work. That this general award should go to the leading figure in engineering publishing is a recognition of the importance of this field of endeavor.

And such recognition may well be given, for the technical press is daily becoming of greater weight in American industry. Under modern conditions education cannot stop at the completion of school, if the individual is to be successful. School gives but the foundation, the fundamentals upon which the structure of a man's education can rest.

Advertising and editorial matter are both essential parts of this help that the engineering journal brings to the technical man. Editorial matter tells him what his contemporaries are doing and how they are doing it. It keeps him abreast of his specialty, explaining the new things. And always, it endeavors to instruct in the latest and best engineering practice.

Advertising, generally thought to tell the engineer only what he can buy to do his work with, actually does much more. It instructs the reader in the use of the tools of his trade and gives him an opportunity continually to compare, in the market place of his paper's advertising pages, the equipment with which his work is done.

In the light of these facts one cannot but be gratified that this award has come to the engineering press from an outside source of the standing of Harvard University. It confirms the good judgment of the readers of that press. And, by showing technical paper publishers that their work is along the right lines, it will encourage them to give even better service to their readers in the future.

Imagine the Savings!

IMAGINE what a difference it would make in the results obtained by some industrial plants if the operation and maintenance of the material handling equipment were in charge of the power engineer. Production is an exacting occupation, and those in charge of it can function better if their attention is not divided. Maintaining and operating service equipment such as conveyors can better be done by someone else, leaving the production man free for his own work.

And the power engineer is the logical man to do this. In the first place, he has to supply the power that operates the material handling equipment. And secondly, material handling equipment is, fundamentally, power transmission equipment and can be best cared for and operated in conjunction with other equipment of the same type.

In spite of the fact that management nearly always classifies material handling as a non-productive operation, there are some plants that still place it under the production executives. This is probably another case where tradition outweighs common sense. But, should common sense finally prevail in such plants and the oversight of the material handling equipment be given to the power engineer, imagine the savings that could be made!

IDEAS *from* PRACTICAL MEN

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

Using Up Old Piping Around the Power Plant

THERE are many uses for old piping around the power plant, such as framing, studding, pipe-line hangers or supports as shown in the illustration.

In the case illustrated, a manufacturing establishment had to build a heavy pipe line between two units of the plant, which were about 300 yd. apart. One end of the pipe line originates at the surface of the earth and is gradually elevated until the opposite end is twenty feet above the ground. Trestles had to be provided at the union of each of the sections of piping, so it was decided to utilize some old 4-in. steam piping for this work. At each joint in the pipe line a stand was made of three

Old pipe used as trestles for the pipe line

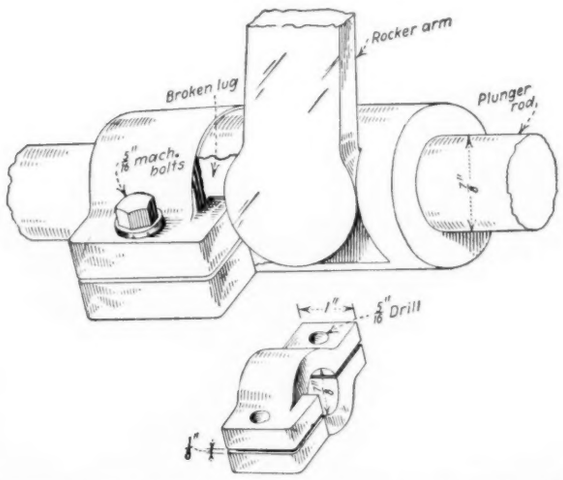
pieces of the piping and two ell unions. The pieces of piping forming the posts are inclined toward each other at their top ends, and the cross-piece is bent slightly to allow this and to form a cradle for the pipe. The posts of the trestles are set in concrete.

This same plant was in need of a long chain conveyor, so a framing was built of old 5-in. piping, the stands being arranged like those seen in the photograph, but instead of ell unions at the top ends of the posts, tee unions were used, so that the pipe could be extended upward to form supports for the top run of the chain. This conveyor is used to carry waste wood to a fire pit to be burned. At the end of the conveyor it was necessary to install a fire pan to extend out over the fire. To support the outer end of this fire pan, two long sections of pipe were used. By utilizing old pipe for this work, there is no danger of fire destroying any of the framing and no cost was involved other than the labor in fitting the old piping together. L. M. JORDAN.

Cairo, Ga.

A Quick Repair for Boiler Feed Pump

ONE of the lugs of a valve-operating collar on a boiler feed pump broke off as shown in the illustration, causing the pump to stop while the plant was running. As the collar was solid and pinned on the plunger



Forged clamp used to replace broken section of collar

rod, it would have been necessary to dismantle the pump to replace it with a new one.

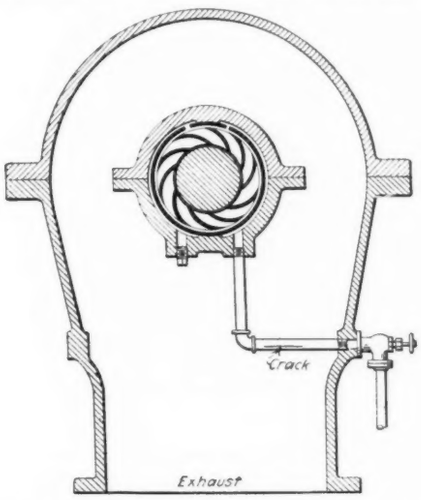
A quick repair was effected by making a circular clamp as shown and clamping it to the plunger rod. The clamp was made of two pieces of flat iron $\frac{3}{16}$x1$\frac{1}{4}$ in. It is provided with a projecting lug that bears against the rocker arm and against the cam on the rod. This repair was made in about 1$\frac{1}{2}$ hours and caused no shutdown, as the injector was used to keep the water in sight while the pump was down. To dismantle the pump and put on a new cam would have taken several hours at least.

Syracuse, N. Y. H. L. WHEELER.

Excess Condensate Caused by Gland Water-Pipe Leakage

SOME time ago we were at a loss to account for the excessive amount of condensate from one of our turbines.

After testing the condenser tubes for leaks, we concluded that an excess amount of water was leaking past the water seals on the low-pressure end. But when the casing was removed for the inspection of the labyrinth



Crack in pipe leading to water seal caused excessive amount of condensate

packing, there was no indication of excess leakage. Upon examining the $\frac{3}{4}$-in. water pipe that passed through the exhaust chamber to supply the seal, as shown by the accompanying illustration, a crack about six inches long was discovered.

This crack occurred, no doubt, because the pipe was worn thin by the abrasive substances and moisture in the exhaust steam striking it at high velocity. A renewal of this pipe stopped the excess amount of condensate, and a guard was placed over the pipe to prevent further trouble from this source. R. G. SPOONER.

New Bedford, Mass.

Why the Efficiency of the New Boiler and Stoker Dropped Off

AFTER an 84-in. horizontal return-tubular boiler with a hopper-feed hand stoker had been installed and a test run made, a high average CO_2 and an evaporation of approximately 10.5 lb. of water per pound of coal was obtained. This gradually dropped off inside of 30 days, so that the estimated fuel consumption was exceeded. The new boiler replaced three small vertical fire-tube boilers, and these were to be sold at junk prices. The steam line, feed line and other piping were taken off these boilers and they were waiting for the junk man to come after them.

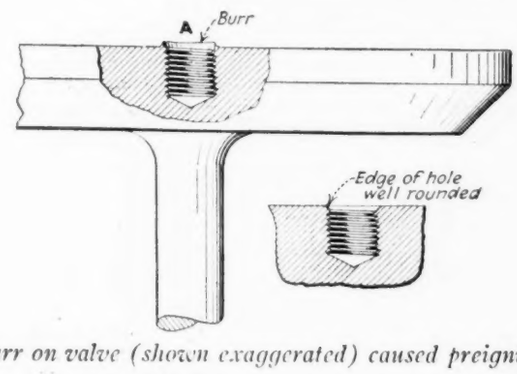
Investigation revealed that much rubbish, consisting of papers, boxes and other combustible material, was sent to the boiler room to be burned, and with the old boiler going out, it had to be burned in the new boiler, which was the direct cause of the lowered efficiency. When the test run had been going on, one of the old boilers was still on the line and all the rubbish was burned under it, so that nothing but coal went into the furnace of the new boiler. Putting in the rubbish took up so much time that much excess air entered through the firedoors. An inspection of the old boilers was made, and the pressure allowed was even higher than that allowed on the new boiler. So it was decided to keep one of them, and work was started at once on the piping connections. With this boiler again in service to burn the rubbish, the efficiency of the new boiler went up again to the test figures and stayed there. It was estimated that the output of the rubbish-burning boiler was 1,000 lb. of steam an hour for 15 hours a day, and had no other boiler been available, it would have paid to install a small one especially for this purpose. In many plants a furnace under a boiler is used to burn rubbish, which, as in my case, results in large savings in fuel being made. A. F. SHEEHAN.

Springfield, Mass.

Burr on Valves Caused Preignition in Gas Engine

A FIFTY-HORSEPOWER gas engine had been running for some time, and the engineer in charge decided to grind the valves. They were removed, and in order to hold them for grinding (there being no slot), he drilled and tapped a hole at *A*, $\frac{7}{8}$ in. deep, and screwed in a bolt to serve as a grip for the grinding tool. When the work was finished, the valves were replaced, but the engineer did not trouble to plug the holes. When the engine was put into service, serious preignition and detonation occurred, resulting in a cracked exhaust-valve chamber.

Upon investigation as to the cause for this, it was found that a slight burr had been thrown up when the threading was done, and this had been raised to such a high temperature by the heat of combustion that it caused preignition. Had the engineer plugged the hole



Burr on valve (shown exaggerated) caused preignition

and smoothed it level with the valve top, the accident would not have happened. There is, however, the danger of a plug's working loose. The most practical thing would have been to have rounded the edges of the hole as shown in the detail, as even if no burr is left, carbon is likely to settle on a sharp edge like this and form a point, which is soon raised to incandescence. If the edge is rounded, the carbon is not likely to form a point, but will settle evenly over the surface. W. E. WARNER.

Shefford, England.

COMMENTS *from* READERS

Relative Speed of Center and Rim of Locomotive Wheel

REFERRING to the answer to question 5 of the "What Do You Know" column in the Nov. 8, 1927, issue, it is my opinion that a point on the top of the wheel moves exactly twice as fast as the center of wheel in a horizontal direction, if the wheel does not slip. If one doubts this, he has only to observe a caterpillar tractor.

The top track of the caterpillar moves twice as fast as the tractor or centers of the wheels, while the bottom track is stationary on the ground. The track accelerates on the rear wheel until it reaches a point on the top of the wheel, and when it reaches the front wheel it is retarded until it comes to a stop on the bottom of the front wheel.

A. H. HALLADAY.

Spring Valley, Ill.

* * * *

Causes of Dangerous Boiler Corrosion

OWING to my absence in Europe the article by K. Von Eltz, in the Jan. 3 issue, has been delayed in reaching me.

The feature under question, as stated in my contribution which appeared in *Power* of Dec. 13, 1927, is the statement by C. E. Stromeyer that boiler sediment produced by compounds remains in the boilers which, so he said, is not the case where water softeners are used.

I maintain from practical knowledge of hundreds of power plants, both in the United States and in Europe, that you do get deposits when using softened water from softening plants, even when those plants are operated as intended.

In this direction, users of such plants will no doubt confirm the experience, and it usually takes two or three days after a softening plant filter has been cleaned before the softener is working at its best. During those first few days the excess of sediment, colloidal chalk, passes through into the boilers.

According to the figures given by Mr. Von Eltz for a lime-barium-carbonate softened water, calcium sulphate and magnesium sulphate are entirely removed. If barium carbonate is used in dealing with permanent hardness due to sulphates, how is it that the sodium sulphate in his softened water figures is entirely unaffected? Theory and experiment show that sodium carbonate should be formed, and the resulting water in the boiler, being concentrated, would have the disadvantages due to the presence of this substance.

Similar remarks apply in greater force to the zeolite softened water. The zeolite plant introduces sodium carbonate in the concentrate it normally reaches, and this is objectionable in boiler waters. The colloidal method does not materially increase the dissolved solids nor does it add carbonate of soda to the water.

An important point to bear in mind is the purpose for which the water is to be used, whether for process work in dyeing, textile factories and laundries, or for boiler feed for steam generation. In the latter case a softener can introduce objectionable features to the water. For example, the zeolite plant, if there is any temporary hardness in the water, introduces bicarbonate of soda into the boiler, and this will yield caustic soda, tending to embrittlement in high-pressure boilers. Lime-soda plants with permanent hardness due to sulphates yield sodium sulphate, which, with the possibilities of high concentration in boilers of today, would give a sodium sulphate scale.

It was with the object of having greater regard for the purpose for which water is required that "collodial conditioning" was developed. This treatment has the advantage of dealing with some of the impurities externally, so that not all of the 11.9 of calcium carbonate referred to in the Dec. 13 article goes forward to the boilers. The water entering the boiler is really better, therefore, than the figures for colloidal condition indicate.

If readers desire to get an independent view on water conditioning and softening, I refer them to Bulletin 24, of the Carnegie Institute of Technology, published last year under the title "Mining and Metallurgical Investigations," as this stresses the important difference between water softening and water conditioning.

M. W. BANNISTER,
Feedwaters, Inc.

New York City.

* * * *

Why Do Boilers Shake?

I BELIEVE that the answer given by Earle S. Mason in the Dec. 27, 1927, issue as to "Why Boilers Shake," is a good one. This applies particularly to fluid fuels. Mr. Nason mentions his experiences with oil.

I have personally encountered serious vibrations of boilers when fired with gas, especially with the multi-jet burner where a group of small jets fire through holes in a casting. This has occurred on all types of boilers from 500-sq.ft. horizontal return-tubular to 10,000-sq.ft. water-tube boilers.

This usually occurs when the draft is sufficiently high to induce a good mixture of air with the gas. I believe it is due to the increase in flame propagation back to the burner with the more intimate mixture of gas and air tending to give a roaring and vibrating combustion. The boiler setting then takes up the vibration like a resonator and the entire boiler house seems to vibrate.

Admission of secondary air or the lengthening of the flame away from the burner stops the vibration.

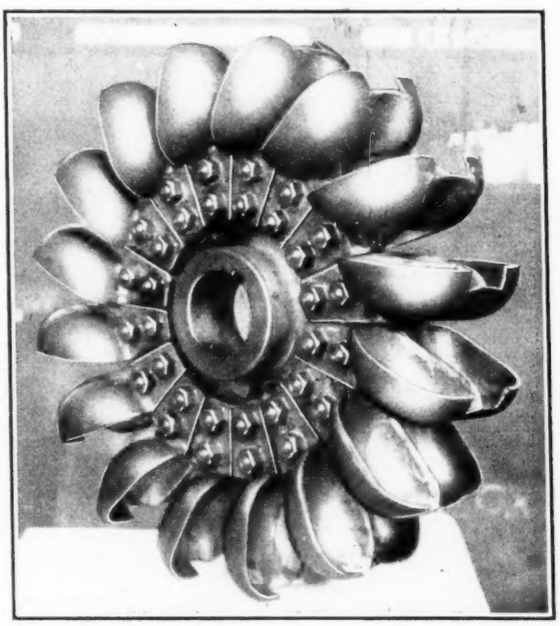
C. W. STEVENS.

Tulsa, Okla.

Preventing Corrosion of Hydraulic Turbines

IN THE Oct. 7, 1924, issue, page 576, is an article entitled "Preventing Corrosion of Hydraulic Turbines." This article referred to an impulse wheel with cast-bronze buckets which carried two monel-metal buckets on opposite sides of the shaft. These buckets were inserted to observe the relative rate of wear on bronze and monel metal for this type of equipment, as considerable trouble has been experienced with previous bronze buckets due to erosion by gritty particles in the water and to corrosion caused by the sulphur content in the water.

After several years of service it was determined that the monel-metal buckets gave approximately 70 per cent increase of service over the bronze buckets. New wheels



Impulse wheel with monel-metal buckets

with all monel-metal buckets will cost the user only 25 per cent more than wheels fitted with bronze buckets, and two new impulse wheels have recently been completed and shipped to South America for service in the same plant. The figure shows one of the these wheels.

New York City. L. MULLER THYM.
The International Nickel Co.

* * * *

Saving With an Accumulator

IN THE Jan. 10 issue, there is an interesting letter from R. A. Langworthy, dealing with his discussion at the New York A.S.M.E. meeting. In view of the rather indefinite way in which the terms of return on investment and savings are made, and in view of the fact that in the last paragraph of the letter he definitely states, "You can plainly see that the statement of a saving of 10 or 11 per cent practically puts the accumulator out of the running," it might be well to quote directly from the paper that Mr. Langworthy recently presented before the Western Society of Engineers in Chicago, where the average of a number of plants that he listed came to 11.3 per cent saving.

Under the heading, "Fuel Savings," in his paper he says: "Due to the ability to operate the boiler plant at constant load with the accumulator as compared to a fluctuating load without the accumulator, very material savings in fuel consumptions are accomplished by its use.

"The amount of savings in any specific case depends upon the characteristics of the particular plant under consideration. Such factors as the type of firing apparatus, size and type of boilers, kind of fuel burned, amount and frequency of load fluctuations, requirements in process work—all enter into the problem, so that generalization on this subject is not possible.

"Savings as high as 30 per cent have been made in extreme cases. An average of eight plants as listed below is 11.3 per cent. It will be noted that none of the plants showing very high savings have been included in this list, so that it may be taken as a conservative statement. Few plants where a real accumulator application exists show a fuel saving of less than 10 per cent."

Industry	Saving, Per Cent
Sugar	15
Paper	15
Paper	15
Textiles	10.3
Brewing	12
Textiles	5
Textiles	8
Textiles	10
Average	11.3

Of course a fuel saving of 25 per cent might represent a return of 25, 50 or 75 per cent on the investment, depending upon the cost of equipment and the fuel consumption of the plant. In view of the fact that Mr. Langworthy apparently contradicts himself, I feel that he should clear up the matter with something more than mere generalized statements—for instance, the cost of the equipment, the saving in dollars and cents of each particular installation and the method by which these savings were calculated. Of course we all realize that it is practically impossible to fix a definite value of savings made by improved equipment of this kind, even though we consider that the saving is there, either in reduced coal consumption or increased ease of operation and improved industrial process conditions.

After definitely stating that the average saving in eight plants was 11.3 per cent and that savings as high as 30 per cent had been made in extreme cases, I cannot understand Mr. Langworthy's objection, so that people "reading this issue will not carry away the impression of a 10 per cent to 11 per cent saving."

Chicago, Ill. M. H. RICHARDS.

[In order to clear up the points in question, Mr. Langworthy was asked to reply to Mr. Richards' comments so that their views could be published together, Mr. Langworthy offers the following explanation of his previous figures.—Editor.]

The statements made in my paper before the Western Society of Engineers and in my letter which appeared in *Power* of Jan. 10 are neither inconsistent nor contradictory. Mr. Richards has simply failed to understand them.

In the paper, containing the tabulation of saving, I referred to *fuel savings only*. The tabulation is a correct statement of the *fuel savings* in the eight plants listed.

It has become almost standard practice in the manufacturing industry in America to require a gross return, before making an investment in new equipment, of at least 25 per cent (in some chemical plants and special industries this rule cannot be applied).

Mr. Richards has failed to distinguish between fuel savings and return on investment. A fuel saving of 5 per cent might in some cases mean a return on the investment of more than 25 per cent. My letter, which was published in your issue of Jan. 10, refers to return on the investment. It is correct as printed.

In the case of the Ruths Accumulator the fuel savings are only part of the total return. Other items, such as decreased maintenance on boiler-plant equipment, decreased cost of purchased electrical power, decreased labor costs, increased production, better quality of products due to uniform conditions, etc., enter into the problem. Some of these factors are present in each specific case, and only a careful analysis of the data for a specific plant will determine the answer.

R. A. LANGWORTHY,
Vice-President & General Manager,
New York City. Ruths Accumulator Co.

* * * *

Emergency Bushing for Split Pulley

IN THE Jan. 3 issue H. L. Wheeler tells how he made a bushing for a steel pulley out of hardwood strips in an emergency.

Inasmuch as Mr. Wheeler lives in the city, where bushings can doubtless be purchased, I wonder if it would not have been easier for him to have gone to one of the supply companies for the proper size of bushing to fit his shaft.

Nearly all mill supply companies these days carry a complete stock of interchangeable bushings which are purchasable at a small cost. Factory-made bushings are invariably superior to home-made bushings. In fact, this applies to nearly anything—factory-made is almost invariably better than home-made.

Newark, N. J. W. F. SCHAPHORST.

* * * *

Preventing Boiler Fractures Due to Caustic Embrittlement

THE answer to Question 8 in the "What Do You Know" column in the Dec. 27, 1927, issue, prescribes the adding of sulphuric or hydrochloric acid to the boiler water until it is neutral or slightly acid, in order to prevent boiler fractures from caustic embrittlement. It seems to me that this is a dangerous procedure.

Practically all power plants that use acid in their feed water add it for the purpose of reducing the alkalinity somewhat, but rarely if ever is the alkalinity entirely neutralized. A further purpose of adding the acid is to control the ratio of sulphate to sodium hydroxide, which, if maintained above a certain point (which varies for the boiler pressure in use), apparently prevents embrittlement. The use of a hydrochloric acid would not accomplish this, since a chloride would be formed.

Caustic embrittlement failures are not numerous and always occur in the seams. It is held by many that the concentration of caustic may become excessive at these points. In order to prevent this, the seams of many boilers are now calked or welded only on the inside (water side), which will prevent any accumulation or concentration of caustic.

In connection with this subject it might be mentioned that practically every boiler compound of any merit has an alkaline reaction. In the Naval Service it has been the practice to maintain the boiler water constantly at an alkalinity between 0.3 and 0.5 per cent normal alkaline strength. As far as known, there has been no record of any boiler failures ascribed to caustic embrittlement. Troubles from corrosion and pitting, however, have been encountered through failure to keep the water at least 0.3 per cent alkaline. Immersion tests indicate that water slightly acid or neutral is much more corrosive than water slightly alkaline. T. A. SOLBERG,

Annapolis, Md. Lt. Comdr., U.S.N.

Answers To What Do You Know

The questions are on page 325

Ans. 1—The load on the bolt, whether due to inertia or to initial tightening of the nut, produces a stress on the bolt. As long as the unit stress is below the elastic limit, the elongation of the bolt is proportional to the stress. If the smallest diameter is at the root of the thread, a greater part of the elongation will take place at this point, because the greatest unit stress is here and the bolt may break. If the bolt is reduced in diameter, the elongation will take place over the entire reduced portion and the bolt will not rupture.

Ans. 2—As the bolt is elastic compared to the pieces clamped by it, the stress will be equal to either the initial tension or the working load, whichever is the greater.

Ans. 3—The Prime Movers Committee of the N.E.L.A. recommend that there be 10 per cent greater area provided in turned bolts used than in case of completely threaded bolts.

Ans. 4—Assume the engine is being shut down and the water flow has been discontinued. If, now, the absolute pressure in the head be equivalent to, say, 4 ft. of water, we have a condition where atmospheric pressure, 34 ft. of water, is pressing on the surface of the tailrace, while inside the tail pipe the pressure is 4 ft. at the top. If the tail pipe is not sufficiently buried in the tailrace, the atmospheric pressure will force the water down along the outside of the pipe until some air can enter the bottom of tail pipe. As the air rushes up through the water in the pipe, the water density is decreased to a point where it requires more than 36 ft. to balance the atmosphere pressure; this being true, water will enter the mixing head and reach the engine.

Ans. 5—As one B.t.u. is equivalent to 778 ft.-lb. and one horsepower-hour is equivalent to 1,980,000 ft.-lb., it requires 2,545 B.t.u. to be equivalent to one horsepower-hour. The value of the Joule equivalent is 777.54 ft.-lb. instead of 778, but the latter value is generally used.

Ans. 6—It is not necessary to have the splice over four inches long.

Ans. 7—The efficiency increases with an increase in superheat.

Ans. 8—The pipe leads air into the scavenging air pump of the Bethlehem Diesel.

New and Improved EQUIPMENT

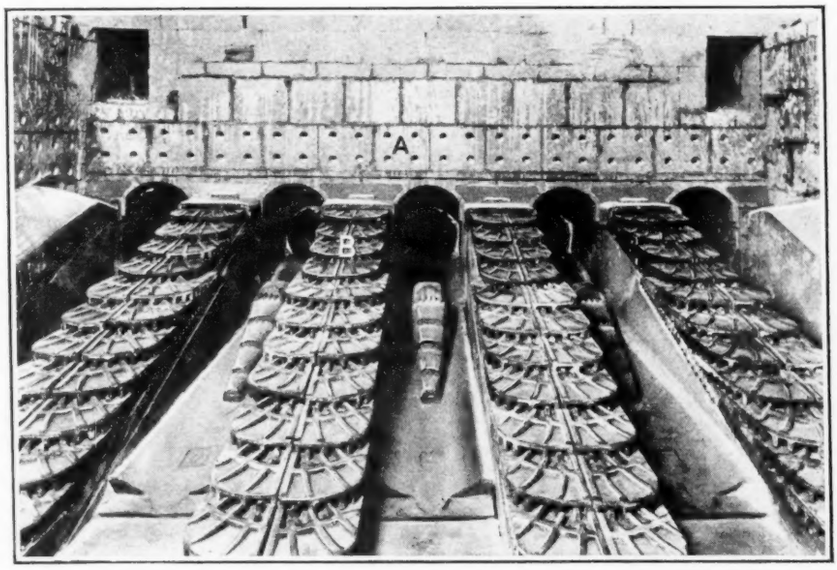


Fig. 1—View of stoker showing narrow grate blocks at front and means of admitting air over fuel bed

Improved Riley Super-Stoker

IMPORTANT improvements have recently been made to the underfeed super-stoker manufactured by the Riley Stoker Corporation, Worcester, Mass.

Referring to Fig. 1, which shows a view of the stoker from the rear, provision has been made for admitting air over the top of the fuel bed by means of special ported refractory blocks in the front wall. The amount of air so admitted is under the control of the operator. The control consists of a sliding damper which is operated by a hand lever at the front of the stoker.

Another important improvement is in the grate block construction. The length of the more recent multiple-retort stokers demands a large coal-feeding capacity. In order to obtain this capacity without undue wear of the moving parts because of the high speed required if small-diameter plungers are used, a large-diameter and long-stroke plunger has been adopted. To overcome the disadvantage of a large plunger, which is a rather high ratio of retort area to grate-block area, four grate blocks at the front of the stoker have been made narrower as at *B*, Fig. 1, and the remaining grate blocks widened. This construction gives higher capacity, greater pick-up and flexibility.

Each section of the stoker is provided with a damper (Fig. 2) which is under the control of the operator so that he may supply more or less air, depending on the fuel conditions at any particular point throughout the length of the stoker. These dampers are controlled from the side wall of the boiler by means of the rods *E* shown. The accompanying views show the damper *C* wide open, damper *D* closed and the damper *F* partly open.

The clinker-grinder operating mechanism has been re-designed to provide a more variable means of control. The drive for the double-roll clinker grinder is so arranged that either or both rolls can be operated as desired. There is also a variable-speed provision consisting of a cam which permits the driving pawl of the ratchet to engage one, two or three teeth, as desired. The control for the ratchet pawl is independent for either grinder roll, so that the speed of one roll can be varied independently of the other.

The principle of air zoning used on the super-stoker has also been applied to the Jones side-dump stoker, manufactured by this company. The damper *L* (Fig. 3) is used to regulate the air supply to the overfeed section. The damper is adjusted from the front of the stoker by means of the bar *N* and interconnecting link *M*, as shown in Fig. 3.

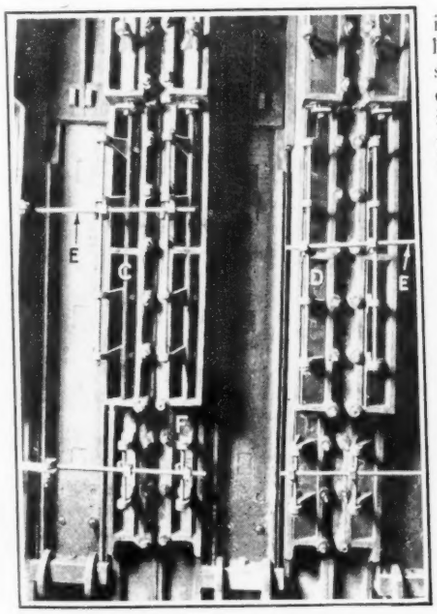


Fig. 2—Dampers for controlling air through the grate sections

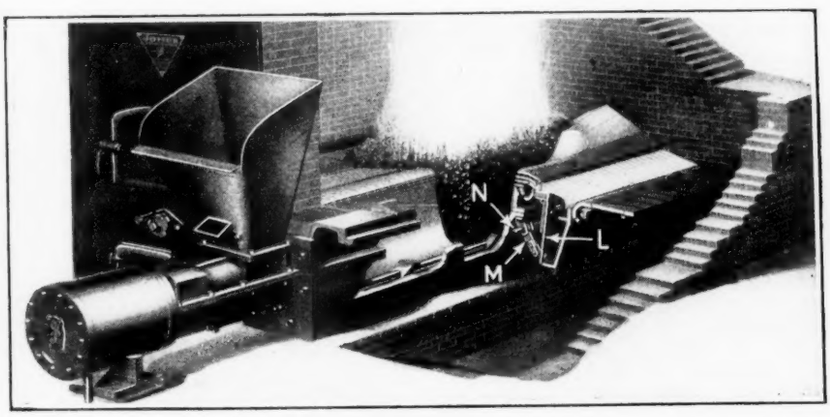


Fig. 3—Air control dampers applied to Jones side-dump stoker

Mid-West Power Conference Features

Flood Control and Power Development

TO PRESENT the broad economic phases of power development to operating and technical interests and at the same time to drive home to the domestic consumers the story of power, so that the public in general might have a better appreciation of its services, was the keynote of the third annual Midwest Power Conference, held at the Stevens Hotel, Chicago, from Feb. 14 to 17, inclusive. In all some twenty papers were delivered at seven sessions by leading authorities in their respective fields.

An entire day was devoted to the relation of power development to flood control and other river problems, an equal period of time to economic phases and developments in the steam power field, a full session to the advancement of the use of power in the home, a luncheon symposium dealing with transmission problems and on the final day an informal luncheon of A.S.M.E. members, at which W. S. Hovey, president of Fairbanks, Morse & Co., spoke briefly to the subject "The Engineer's Part in Business."

Conference a Success

Sponsored by nine different engineering organizations, the Mid-West Power Conference must be voted a decided success. The program was ably presented and a total registration approximating 800, gives some indication of the interest that was aroused.

At the banquet held in the grand ballroom of the Stevens Hotel, Rufus C. Dawes was the speaker and his topic "Engineering Phases of International Finance." Plant inspection this year was concentrated into a single trip to the new sewage disposal works of the Sanitary District of Chicago, which is now nearing completion, and being the largest of its kind in the world, it held much of interest to engineers in general.

In an address officially opening the conference and expressing the keynote of this four-day meeting, Major Rufus W. Putnam, president of the Conference, reviewed a few of the factors that make the subject of power of so much importance in the Middle West, tracing in particular the development of the electric power industry, the trend toward interconnection, the standardization of transmission voltages, the centralization of power and the tendency to undertake large-scale operations that go far toward reducing production costs. In the Great Lakes region, he said, the per capita production of public utility power in 1924 was 602 kw., as compared to 527 for the entire United States, 846 for New York, 620 for Pennsylvania and 1,422 for California. This situation led to the conclusion that the consumption of power for industrial purposes was not as close to the saturation point as its use by other consumers, so that the most productive field of endeavor for the public utility for years to come would seem to be that of serving industrial demand.

Relation of power development to flood control and other river problems; navigation and power development on the St. Lawrence; progress and trend in hydraulic power developments; operating experiences in high-pressure and high-temperature steam plants; trend in the development of steam generation; automatic combustion control; the effect of steam reheating, stage feed-water heating and boiler reheating on steam-turbine practice and development; and embrittlement of boiler plate were among the subjects discussed.

In an address on "Power, the Background of Today's Civilization," Glenn Frank, president of the University of Wisconsin, contrasted the teachings of Gandhi, that man must be emancipated from the domination of machinery, with those of Ratenau, that machinery has been the means of emancipating man. According to the former, mass production centralizes industry, makes for poorer, more congested living conditions and spells the death of handicraft. This doctrine has been gaining many converts in the Western Hemisphere.

Doctor Frank was of the opinion that Grandhi's theory was applicable only to the earlier age of steam power where industry had to go to the source of power. In the present age of electricity, when power can be brought to industry, the necessity for industrial concentration no longer obtains and economic forces are already working toward decentralization with its attendant social advantages.

In spite of the fact that the present machine age involves repetitive operations on the part of the worker, as contrasted with handicrafts of the past, the hours are shorter, wages higher and prices lower—all of which give the worker greater opportunity for leisure or for personal advancement and self-expression. This, in the speaker's opinion, instead of cultivating mediocracy, gives the worker of limited ability a better chance.

Power Development and Flood Control

National interest centered in the two sessions on Wednesday dealing with the foregoing subject. Gen. Edgar Jadwin, of Washington, D. C., gave a comprehensive treatment of the general flood control problems on the Mississippi system.

On Wednesday afternoon, Maj. L. H. Watkins, of the U. S. Army Engineers, outlined the work that is in progress covering a survey of the Tennessee River. This work, which was undertaken several years ago, is in pursuance of a total appropriation by Congress of $790,000 to cover navigation, water power and flood control on this river and its tributaries. The potential power possibilities of the Tennessee River system, as indicated by the survey, amounts to nearly 4,000,000 hp., of which 326,000 hp. is now installed.

To give a clear idea of the feasibility of the combined use of storage for flood control and for power purposes, Prof. Daniel W. Mead, of Madison, Wis., summarized the actual uses of storage reservoirs already functioning, including the reservoir systems of the Great Lakes, the upper Mississippi, Wisconsin River, Chippewa River, Miami Conservancy District and reservoirs for irrigation and flood control. His conclusions were to the effect:

That approximately complete control of a river system such as is provided by the Great Lakes, is of definite advantage to both flood prevention and water-power development, but that such control is practically impossible by arti-

ficial means on any large river system.

That with partial control on any large river system the combined uses of reservoir for flood protection and other purposes is so antagonistic as to be inexpedient.

That reservoirs, for whatever purpose they may be constructed, will have minor favorable effects for most other purposes in that they will tend to equalize the stream flow.

That, in general, reservoirs should be built and operated for a single purpose when found financially advantageous for such purpose, and that with few exceptions the use of reservoirs for combined services is not warranted except when they can be so used as not to interfere with the purpose for which they were constructed.

Col. William Kelly, of Buffalo, N. Y., analyzed irrigation flood control and power development problems on the Colorado River, giving particular attention to the flood menace in the lower basin, irrigation requirements, a municipal water supply for Los Angeles, and the Boulder Dam proposal, involving a dam in Black Canyon, power plants for developing 1,000,000 hp., an all American canal to irrigate the Imperial Valley and capacity of 8,000,000 acre-feet at the top of the reservoir for flood storage.

Reasons why this entire project was economically unsound, were summarized by the author, and the solution suggested was that flood protection for the lower basin should be separated from the canal, municipal water supply and Boulder Canyon power developments. The flood project could be built in a comparatively short time at a small fraction of the cost and without injustice to the various states in the Colorado Basin.

Maj. Glen Edgar Edgerton analyzed the status of hydro-electric development in this country from the point of view of the Federal Power Commission, of which he is chief engineer. Introducing the subject, he explained the position occupied by the commission and established a basis with which to compare the present status of development.

At the time of its organization in 1920, the potential water-power resources of the country were estimated at 55,000,000 hp., slightly less than 8,000,000 hp. had been developed, and of this total little more than 2,000,000 hp. were subject to Federal Authority.

Today, he said, 55,000,000 hp. still seems to be a reasonable estimate of the aggregate capacity on the basis of power available 50 per cent of the time, and the corresponding figure on the basis of installation capacity is about 75,000,000 hp. Probably about 75 per cent of the total is subject to Federal Authority. The total development has increased from 8,000,000 to 12,000,000 hp. Therefore, at present approximately 16 per cent of the potential water-power resources have been developed, at least 5 per cent is in process of development and about 8 per cent more under investigation with a view to early development. Completed hydro projects of all kinds appear to be supplying about one-third of the total quantity of electrical energy generated in this country.

The Canadian viewpoint on navigation and power development on the St. Lawrence River was clearly brought out in a paper by E. A. Forward. Following a historical sketch of the various steps in navigation on the river from 1700 to the present, the author concludes that traffic conditions do not warrant the expenditures required to provide a 25- or 27-ft. channel for many years to come. In other words, Canada now has transportation facilities far in excess of actual requirements and her chief concern is to secure additional population to provide traffic that will enable them to pay their way.

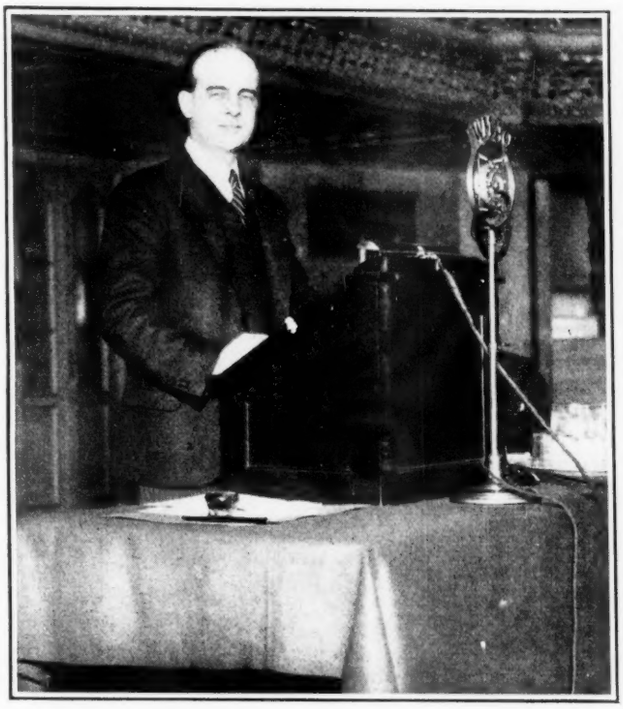
Progress and trend in hydraulic power development was pointed out by H. A. Hageman, chief hydraulic engineer, Stone & Webster. Mentioning briefly the early history of advancement in this field, the author spoke mainly on later progress and the future outlook. In the last 25 years progress had been rapid. Successful methods had been devised for collecting and analyzing stream flow data.

Marked improvement, the speaker said, is noticeable in the detail design of dams and their appurtenances and in the materials of construction. Important advances have been made in the design and construction of auxiliary structures for dams and hydro-electric machinery is becoming less complicated and more efficient. Single main waterwheel units have increased in capacity from 5,500 to over 70,000 hp. and the efficiency from 80 to 94 per cent.

Today modern reaction units of the single-runner, vertical-shaft type predominate over the horizontal units. For heads up to 50 ft. the propeller type runner is displacing the Francis wheel. For heads of over 1,000 ft. impulse wheels for main units are invariably used and usually are of the two-runner, two-bearing, overhung type in sizes up to 56,000 hp. operating on heads up to 2,500 ft. Operation has kept pace with general advancement.

More attention is being given to the use of pondage and storage, and inspection and maintenance schedules. Reference was made to the increasing popularity of electrically controlled automatic stations, particularly at inaccessible power sites on small streams. As the trend is for greater economy in all phases of the art, the author considered the outlook promising for further progress in water-power development.

At the Thursday and Friday sessions the steam power station had its inning. Economics, trends and developments, combustion control, steam reheating, embrittlement of boiler plate and a symposium on power transmission were the subjects featured.



Glenn Frank, president, University of Wisconsin, delivering his address, "Power the Background of Today's Civilization

Power-Station Economies

Alex Dow, president of the Detroit Edison Company and of the American Society of Mechanical Engineers, in one of his characteristics talks commented on some recent economic tendencies in the central-station field from the point of view of the man responsible for results. Troubles that could not be solved by the usual engineering methods were politics and the exploitation by financial groups of the public service industry. The former had to be endured and the latter might be cured by joint action of the utilities.

Over-engineering was more a vice of the past than of the present, although there still was a tendency to overlook a few basic facts. The purpose of a public utility was not to give the best

possible service, for in doing so, the last small percentage in efficiency was likely to cost beyond its value. His definition was to give acceptable service at an acceptable price, which was possible by a careful grading and co-ordination of rates so that there would be no sign of discrimination. To the big user of power rates must be given that essentially compete with the best that the private plant can do. For the small consumer the best way to decrease rates was to increase the use of current. Another factor was keeping the distribution system overhead until the growth of the business warranted putting it underground.

One of the tendencies that was being overdone at the present time was the competition toward maximum thermal efficiency. In certain plants each succeeding unit was being made bigger and better, and the result was a diversity of costly equipment that would not harmonize. Use of foresight to provide for the future would have produced a plant of equal economy at less cost.

Cost of Steam Plants

In one of the Detroit Edison plants burning powdered coal, the sixth unit was going in and its various parts were interchangeable with those of the other five. In the design there had been no effort to use the latest fads, not one of them had been adopted except the use of powdered coal, and this had been selected because it doubled the choice of fuels. Large boilers with plenty of reserve capacity, and substantial easy-running generating units with plenty of room available, medium steam pressure and temperature, and in general a station built harmoniously, so that it would make no difference which unit is in operation, were the chief characteristics of this plant. The cost was $103 per kilowatt, and the net efficiency for the year was represented by an average consumption of 14,813 B.t.u. per kilowatt-hour. Omitting overhead on the investment, but including operation, maintenance and fuel, the cost per kilowatt-hour averaged 3 mills.

For economic development the basic principles to observe were a happy mean, predetermined design, uniformity and careful attention to the small losses.

High-Temperature Steam

An interesting contribution summarizing operating experience with high-pressure and high-temperature steam, was made by George A. Orrok, consulting engineer for the New York Edison Company. This paper appears on page 339 of this issue.

In the discussion of the paper, I. E. Moultrop, of Boston, pointed out that while the curves showed a 1,200-lb. boiler cost twice as much as a unit designed for 200 lb., the cost of a properly designed plant per unit of station capacity need not be any higher than that of the lower-pressure plant. In his opinion steel castings for high-pressure service should be examined by means of X-rays. Troubles that had resulted were due to the making of these castings in quantity without sufficient care. Forged steel, rather than cast-steel for all high-pressure fittings might be the solution. As to the most economical steam pressure and temperature, it was his opinion that the profession today was in a much better position to decide, owing to the great progress that had been made in the last few years.

Steam Generator

"Trend and Development in Steam Generation," a paper by Thomas E. Murray, of New York City, traced the advance that has been made in the boiler room, beginning with the boiler proper, then the furnace and the changes brought about by the introduction of water-wall surface. Improvements in supplying fuel to the furnace were considered, including stokers, the use of fuel oil and gas and the burning of pulverized coal by the central or unit system, with a leaning toward the latter, owing to its simplicity and lower cost. Other auxiliaries and appurtenances were taken up, such as the air heater, economizer, automatic boiler control systems, feed-water treating, gage glasses for the higher pressures, etc. Mention was made of the binary vapor system and other departures from the ordinary system of steam generation, indicated by the Hartmann, Loeffler and Benson boilers.

Personally, the author did not believe there would be standardization on a given steam pressure for power stations. Pressures of 400, 600, 1,200 lb., and possibly higher, would be used, depending upon the particular conditions existing in each station. Boiler sizes, he thought, would increase until a single boiler would supply the steam for the largest prime mover. At present work is in progress on plans for boilers having a capacity of 800,000 lb. of steam per hour. Boilers that would supply at least 1,000,000 lb. of steam per hour next would be installed and it was his expectation that soon there would be units large enough to supply all the steam required by the 200,000-kw., 300,000-kw. turbines or whatever size the future machines may be.

H. W. Leach, of the United Electric Light & Power Company, confirmed Mr. Murray's statements relative to progress in boiler design since the introduction of water walls. Draft resistance and pressure drop through the boiler were now the limiting factors in capacity rather than the furnace. Various factors to be considered for operation at high ratings were enumerated and emphasis placed on the proper relation of one piece of equipment to the other. In fact station design had come to the point where maximum efficiency depended upon the ability of the engineer to combine properly the various component parts of the installation.

John Anderson, of Milwaukee, stated that the high-pressure installation at Lakeside, which carries 30 per cent of the station load, produces a kilowatt-hour on 12,500 B.t.u. and the low-pressure section a kilowatt-hour on 15,800 B.t.u. The actual investment of a 1,200-lb. plant is only 6 per cent over that of a 300-lb. plant, the increase being largely in the boiler. He expressed the opinion that 1,500 lb. represents about the limit of economical steam pressure and that the solution of furnace cooling lies in steam-cooled rather than water-cooled walls, that is radiant heat superheaters surrounding the furnace.

E. H. Tenney pointed out that fineness of grind is no longer regarded as the only important factor in the proper combustion of pulverized coal; but that turbulence of flame, location of the hot zone, control of furnace temperature, protection of the furnace walls and admission of secondary air are equally important. Moreover, as furnace volume varies as the cube of the linear dimensions and as the heat-absorbing area of the walls varies as the square, a square foot of wall area in a small furnace will absorb more heat per unit of furnace volume than a large furnace. Also, the walls of small furnaces are more subject to scouring effect and must be better suited to withstand erosion. Hence, the wall treatment for various sizes will not necessarily be alike.

Symposium on Power Transmission

In this luncheon symposium, "Power Transmission by High-Voltage Cables," was an interesting paper in which H. B. Gear, of the Commonwealth Edison Company, reviewed the progress in cable transmission in Chicago from the 9,000-volt three-conductor type first laid from Fisk Street Station to the six circuit miles of 132,000-volt cable laid in 1927, having a maximum rating of 90,000 kva. The author traced progress in cable development, discussed the reliability of cable circuits and made mention of the charging current needed to offset the static capacity. In the case of the 132,000-volt cable about 2,400 kva. was required to charge a mile of line. An outline was given of the company's methods of distributing the industrial power supply and of the reasons for varying customer voltage.

H. W. Eales, of the Byllesby Engineering & Management Corporation, indicated to the power conference the extent of the studies and experiments that are being carried on by the central station industry to insure reliability of service on overhead transmission lines. Nature of structures used, tests on completed structures, improvements in power stations and substations supplying these lines were some of the items considered, all from the standpoint of reliability.

Wallace S. Clark, of the General Electric Company, outlined some of the causes of failures in impregnated paper-insulated lead-sheathed cables.

A. C. Montieth, general engineer of the Westinghouse Electric & Manufacturing Company, in reviewing develop-

ments in apparatus for transmission systems, discussed briefly the investigations conducted and the development of apparatus involved to satisfy the requisites of good service under the following heads: Use of low series reactance, maintenance of machine voltage, protection against surges, rapid and selective isolation of faults, layout of systems to limit short circuits, and the supply of reactive power as close as possible to the point in which the demand originates.

Boiler-Room Problems

At the final session on Friday topics under discussion were confined principally to the boiler room, as there were two papers dealing with combustion control, one summarizing investigations in plant and laboratory on embrittlement of boiler plate and another discussing the effect of steam reheating and stage feed-water heating on steam turbine development.

T. A. Peebles, of the Hagan Corporation, in discussing combustion control for industrial plants, showed that such plants had profited by following the progress made in central stations. It had been impossible, however, to follow their lead in operating organization, owing to the number of competent men involved, and to the fact that the executive head of the average industrial organization devoted most of his attention to departments of the business representing from 90 to 98 per cent of his annual expenditures.

With modern plants in many cases ideal for the intended service, it was only natural that industrial plants should first appreciate the advantages of combustion control and, by installing equipment that automatically adjusted conditions, leave the operator free to supervise the furnace. The principal advantages of such control, he said, were: Proper division of the load among the boilers in service, adjustment of combustion rate in accordance with load, and the proportioning of the fuel and air supply.

On each of these operations the author had something specific to say and continued by citing other special control problems coming up in industrial plants, such as pressure reduction and desuperheating between high-pressure boilers and a distributing system at lower pressure, and the simultaneous burning of two fuels—for example, blast-furnace gas and powdered coal—that could be solved by special applications of the standard combustion control apparatus.

J. F. Shadgen, of the Smoot Engineering Corporation, approached the combustion-control problem from a slightly different angle. Proceeding on the basis that modern combustion control was an extension of the principles of scientific management, the author led up to the final conclusion that a perfect organization plan for boiler-room operation could be built around a comprehensive combustion-control system and that all elements were available and adaptable to any local problem. Any control system was to be used as a tool to the combustion engineer of the plant to allow that man, together with his operating crew and test gang, to maintain maximum efficiency over monthly and yearly periods independently of load fluctuations and variations in the coal supply.

Thus the management of the boiler room, the speaker said, would be composed of a combustion specialist as general, responsible supervisor, using the instruments as inspectors and performance checkers, the test engineers as tool setters, and the operators to keep a set of regulators and equipment in harmonious co-ordination. Each part had its definite function, as in a well-managed machine shop with automatic tools. To aim at complete automatic control was erroneous, because no managing head could be replaced by a machine, no matter how perfect or ingenious.

In the discussion of the papers on combustion control, the opinion was expressed that the investment in control was usually paid for in coal saved in less than two years; that present systems should be simplified so that operators can readily understand them; and that competent boiler-room supervision must accompany the use of automatic control.

Edwin Brown, of Allis-Chalmers Manufacturing Company, outlined the considerations given by a turbine builder to the problems arising from application of reheat and regenerative cycles. The regenerative cycle has made for changes in turbine design, and reheating of the steam is still altering the course of turbine development. The latter has made possible the highest-pressure turbines now used. Full abstract of this paper will be published in a later issue.

Boiler-Plate Embrittlement

"Embrittlement of Boiler Plate," by Prof. S. W. Parr and F. C. Straub, was an excellent paper in which was reviewed the type of cracking, the characteristics of the cracks and the water conditions in some 300 boilers that had encountered difficulty from embrittlement. Reference was made to recent instances of embrittlement involving 25 different boilers. The causes of embrittlement and the results of a laboratory investigation into intercrystalline cracking were summarized and the effects given of new inhibitants, such as sodium phosphate and tannate, that may be used to prevent embrittlement where the sulphate treatment is not suitable. A comprehensive abstract of this paper will be published in an early issue.

Discussing this paper, S. H. Powell said the number of boiler failures is small but there are enough to direct attention to their cause. High pressures make this question a more pressing one and necessitate further study. In his reply Mr. Straub said that he had made tests to 1,500 pounds, but plans to go to 2,000 pounds.

Hydro-Electric Development in New Zealand

SINCE 1925 rapid progress has been made in hydro-electric development in New Zealand. During the fiscal year ended last June, the sum of $6,207,000 was spent on new works. This brings the expenditure to $30,000,000, but of this $9,600,000 is in plants not yet in operation. On three plants in operation, Coleridge, Horahora and Mangahao, $22,400,000 has been spent, and during the last year they returned 7 per cent on the investment. Even Mangahao, which began delivering power last year, returned 4 per cent. Substantial depreciation, sinking and reserve funds have been started.

A plant of large capacity is being built at Waikaremoana, in the eastern part of the North Island; and one of considerable size is planned for the southern part of the South Island. At the Arapuni works, North Island, planned for three 25,000-hp. turbines connected to 18,000-kva. generators, and where eventually eight of this capacity will be installed, the work has been retarded on account of the difficulty in finding a suitable location for the power plant.

The contract for this development was awarded in 1924 in two sections. Construction of the dam called for an expenditure of $2,930,000 and for the power house the cost was to be $2,710,000. The Waikato River was temporarily diverted and the dam has been virtually completed. On Dec. 31, 1927, the reservoir was filled. But the contractor could not find reliable foundations for the power house, and a dispute arose with the Public Works Department. Eventually, late in 1927, an agreement was signed by which the contractor was to complete the first section of the works and be paid for part of the second section, and the government would finish the power house. The contractor estimated that it would take 37 months to finish the job; government engineers say that they can do it in 18 months at little extra expense above the original estimate. Most of the machinery has been delivered to the site, awaiting the completion of the plant. The anticipated revenue from this plant is $720,000 per annum.

Bulletin No. 68, containing an analysis of interstate transmission of power by electric light and power companies in this country during 1926, has recently been issued by the Bureau of Business Research, Harvard University, Boston, Mass. This bulletin, which has 13 pages, also gives an analysis of power transmission across the Canadian and Mexican borders. An analysis is made according to states, and a map is included that shows the number of transmission lines crossing state and international boundaries. Copies of this bulletin can be obtained from the Bureau at $2 each.

Power System Interconnection an Outstanding Subject at A.I.E.E. Convention

Transmission lines have extended until it is now possible to tie Boston, Mass., with Chicago, Ill., Hattiesburg, Miss., and Pensacola, Fla., with power lines. This does not mean that power is transmitted from one of these points to another, but the physical connections have been made

AT THE midwinter convention of the American Institute of Electrical Engineers, held in the Engineering Societies Building, New York City, Feb. 13 to 17, the meeting on interconnection and its effect on power development was one of the outstanding events. This session was held under the auspices of the Power Generation Committee of which W. S. Gorsuch is chairman. Four papers were presented and were discussed by a number of prominent engineers.

It was evident from these papers that interconnection is no longer an academic question, but has been proved time and again to be the outgrowth of sound economic developments. The power system started in or near centers of population and spread out until they came within distances of each other that made it advantageous for them to tie together. In this way the tremendous interconnections of today developed.

This interconnection was in the process of development before such fascinating phrases as "superpower" and "giant power" were coined. Although none of these proposals has been carried out as suggested, it is today possible to tie Chicago, Ill., Boston, Mass., Hattiesburg, Miss., Mobile, Ala., and Pensacola, Fla., together by power lines. Such connection as between Chicago and Boston, and Chicago and Pensacola, Fla., have been made and the systems operated in parallel for fifteen minutes or more for test purposes. Outside of the state of Maine it is today possible to tie together practically all the states east of the Mississippi River in a network of power lines.

Conowingo Development

In a paper, "Conowingo Hydro-Electric Project, with Particular Reference to Interconnection," by the late W. C. Elgin, and presented by N. E. Funk, the Conowingo project, now nearing completion, and the proposed interconnection between the Philadelphia Electric Company, the Pennsylvania Power & Light Company and the Public Service Electric & Gas Company, were described. The Conowingo plant, which is in Maryland, on the Susquehanna River, will, when completed, have eleven 54,000-hp. units. In the initial installation there will be seven main units. At full gate each of these units will require about 6,000 sec.-ft. of water. Records of the river indicate that several times the average flow of the river at Conowingo has been less than 6,000 sec.-ft. for four months or more, and at times the average flow is less than 5,000 sec.-ft. The greatest flow of the river reached 750,000 second-feet.

The low-flow features of the river have, more than any other, prevented the development of this power site until this time. The project has now been made economically justified because the Philadelphia Electric Company system load is large enough to absorb nearly the entire output of the plant at all times; while operation in connection with the existing steam stations in Philadelphia, utilizing Conowingo station on the base of the load in high flow and on the peak in low, makes relay steam capacity unnecessary.

Interconnection in Southeast

On the interconnected system which W. E. Mitchell discussed in his paper, "Progress and Problems from Interconnection in the Southeastern States," there are 1,362,167 kva. of hydro-electric and 622,487 kva. of steam capacity, which in 1927 produced 4,150,000,000 kw.-hr. This system consists of a network of over 5,000 miles of high-voltage lines extending over seven of the Southeastern States. On Dec. 3, 1927, systems from Chicago to Mobile, Ala., and Pensacola, Fla., were interconnected, and thus over a thousand miles of transmission line literally millions of kilowatts in generating capacity operated in parallel for about fifteen minutes. No power was interchanged, but the availability of the interconnections in case of emergency was demonstrated.

The paper, "Some Aspects of Pacific Coast Interconnection," by P. M. Downing, tells of power-system interconnection along the Pacific Coast and in general gives the reasons for and the advantages of interconnection between power supply systems. It enumerated five essential factors that must be considered in successful operation of interconnected systems; namely, dependable communication, centralized authority and control over operations, location and isolation of trouble, voltage regulation and control over the entire system, and frequency control.

Some of the more important advantages to be gained by the interconnection of two or more different power supply systems are, as given by Mr. Downing:

1. Greater reliability of service and increased economies. In case of a shortage of power due to accidents to equipments, other similar equipment on the interconnected system can supply the shortage until repairs are made or other units put into service. Under normal conditions the more efficient units can be operated, the less efficient being held in reserve and operated only in emergencies.

2. Increased diversity, thus reducing the power requirements of the combined systems and, by improving the load factor, reducing the capital investment in plant facilities.

3. Common use of reserve or spare capacity, thus reducing the capital investment in plants.

4. In cases where the network is supplied with power from both steam and hydro sources, the hydro stations can be operated continuously at full load when water is available, thus making a maximum beneficial use of water power and a minimum use of steam. On a smaller system there would be much less opportunity of doing this.

5. General availability of power over large areas, thus making it possible for factories to locate where raw material, labor, market conditions, etc., are most favorable. This is particularly important, as it permits manufacturing plants to locate in smaller towns and agricultural areas and use labor normally employed during certain seasons only. In this way interconnection becomes an active force in the decentralization of population.

Power in Chicago District

It was Mr. Downing's opinion that, although there are many arguments in favor of interconnecting power systems, the extent to which this can be done has limitations beyond which there is no advantage in going.

In his paper, "Interconnection and Power Development in Chicago and the Middle West," H. B. Gear told how the power stations in Chicago have developed, how small stations have been replaced and how the energy supplies from light, power and traction have been consolidated by high-voltage lines connecting modern high-efficiency plants. Mr. Gear summarized the interconnection of power stations by transmission lines of relatively large capacity by saying that:

The size of generating units is increased, while the total capacity and reserve for a district is decreased; the investment per kilowatt of capacity in generating stations and the total investment are decreased; the consumption of fuel is reduced by ability to give the more economical units the base load of an entire district; the reliability of service is enhanced by increased availability of the capacity and reserve in generating units, during emergencies and routine operating work, such as overhauling and repairing equipment.

NEWS *of the* FIELD

Senate Votes 46 to 31 for Power Inquiry by Federal Trade Commission

Walsh Proposal for Senate Investigation Beaten After Nine-Hour Debate by George Amendment—Probe Limited to Events Since 1923, Not to Question House Member Elections

BY A VOTE of 46 to 31, and over the determined protest of Senator Walsh of Montana, the Senate, Feb. 15, referred the proposed "power trust" investigation to the Federal Trade Commission, instead of authorizing an inquiry by a special committee of five Senators as proposed by Mr. Walsh.

The final vote came after a nine-hour session of bitter debate, marked by frequent clashes, particularly between Senators Glass of Virginia and Bruce of Maryland. Senator Walsh of Montana, many of the Democrats and a large proportion of the Progressive Republicans tried to defeat the motion to hand the inquiry over to the Trade Commission, as proposed by Senator George of Georgia.

Hoping that delay might gain more votes in favor of a Senate investigation, Senator Walsh and his lieutenants endeavored three times to adjourn the Senate. They were defeated in increasingly decisive votes. Senator George and Senator Watson, chairman of the Senate Interstate Commerce Committee, were willing to agree to give a specific time to vote, but Mr. Walsh refused to consent.

Senate Inquiries Condemned

The outcome of the fight was in doubt until the vote was taken, although the advocates of the Trade Commission plan were gaining strength on the preliminary votes.

Once during the debate, which at times was bitterly personal, Senator Bruce condemned the increasing tendency of the Senate to investigate "everything under the sun."

"The Senate is drunk with its investigating powers," he declared. "Some people take as much pleasure in investigating as other do in intoxication. It is now high time the Senate investigate itself."

The crux of the contest was over the amendment by Senator George to send the inquiry to the Trade Commission. Mr. Walsh and his forces contended that the commission would "bury" the investigation, and that it was also precluded by law from examining the alleged political activities of corporations, as proposed by Mr. Walsh in his resolution.

The resolution as passed, including the George amendment, directs the Trade Commission to inquire into and report to the Senate "within each thirty days after the passage of this resolution and finally upon completion of its investigation" on the financing of electric and gas companies furnishing power and light in interstate business.

Another provision authorizes an inquiry into the alleged political activities of corporations. It was decided to limit the investigation to any events since 1923, to eliminate any mention of investigating the election of House members, and to dispense with a clause which would "direct" the investigating body to go into that phase. The investigators are merely "empowered" to proceed.

Elections Inquiry Provision

As adopted, the election provision reads as follows:

The committee is further empowered to inquire and report whether, and to what extent, such corporations or any of the officers thereof or any one in their behalf or in behalf of any organization of which any such corporation may be a member, through the expenditure of money or through the control of the avenues of publicity, have made any and what effort to influence or control public opinion on account of municipal or public ownership of the means by which power is developed and electrical energy is generated and distributed, or since 1923 to influence or control elections; provided, that the elections herein referred to shall be limited to the elections of President, Vice-President and members of the United States Senate.

Sessions Open to Public

On motion of Senator George, the Senate adopted an amendment directing the Trade Commission to ascertain whether any of the alleged practices referred to in the Walsh resolution "constitute unfair methods in commerce, tend to restraint of trade and commerce or to create a monopoly, or constitute a violation of the Federal anti-trust laws."

The purpose of this, Mr. George said, was to make certain that the commission would carry out the inquiry and make a proper report on the resolution.

The Senate also accepted an amendment by Senator Black of Alabama, providing that the sessions of the commission during the investigation should be open to the public.

Municipal Hydro-Electric Plant Proposed

At Sandpoint, Idaho, the council at a special meeting on Jan. 17, authorized Mayor H. E. Brown and City Clerk F. H. Strong to sign a six months' option for the water-power permits on the Priest River. Meanwhile the Council expects to investigate the possibilities of erecting a power plant at this site and the probable market for power in that territory.

The Council's decision to take the option came after a study of the report of H. A. Sewall, of the Interstate Engineering & Construction Company, Newport, Wash. The Priest River project is considered an attractive proposition because of the reliability of the water supply and the opportunity for development of future units as the market increases. The total cost of the project selected by the City Council as most feasible is estimated at $165,225.

National Research Council Organization

The National Research Council, Washington, D. C., has issued a booklet giving the organization and personnel of the council for the year from July 1, 1927, to June 30, 1928. Names and addresses are given, not only of the officers and heads of divisions, but also of the members of the various committees and subcommittees charged with carrying out the detailed work of the council. In addition the names of the holders of the various fellowships in the gift of the council are listed. Copies of this booklet can be obtained by those interested by applying to the secretary, National Research Council, Washington, D. C.

Buys Vale, Ore., System

The Vale Power System, Vale, Ore., has been bought by the Idaho Power Company, the transaction taking place the last of January. Kinsey M. Robinson, division manager, will be in charge of its operation.

W. H. Taylor to Head Philadelphia Electric Co., A. W. Thompson Now Chairman of Board Assisted by W. H. Johnson

Former Chief Relieved of Active Direction of Company After Forty-one Years Service—New Head U.G.I. Vice-President in Charge of Operations—Samuel T. Bodine Chosen a Director

WILLIAM H. TAYLOR, vice-president in charge of operations and maintenance of the United Gas Improvement Company, Feb. 14 was elected president of The Philadelphia Electric Company, succeeding Walter H. Johnson, resigned.

In presenting his resignation to the board of directors, Mr. Johnson said it was his desire to be relieved from active participation in the direction of the activities of the company, calling attention to the fact that he had been associated with it for nearly 41 years.

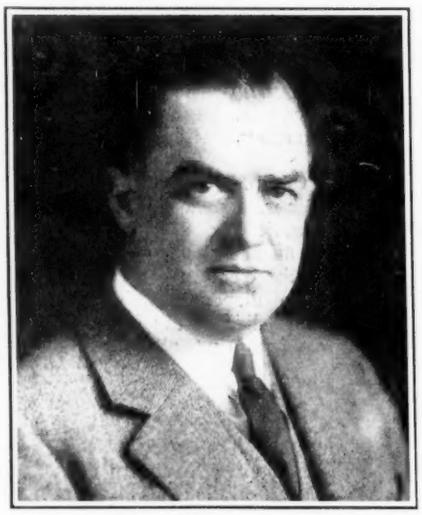
Arthur W. Thompson, president of the United Gas Improvement Company, was elected chairman of the board. Mr. Johnson was elected assistant to the chairman. Samuel T. Bodine, chairman of the U.G.I. board, was elected a director. Immediately after the announcement of his election, Mr. Taylor, who has had 25 years' experience in the public utility industry, said he had resigned as vice-president of the U.G.I.

Mr. Taylor was born in Ashley, Pa., Feb. 3, 1880. He began his public utility career 25 years ago, following his graduation from Stevens Institute of Technology, and a brief connection with the Link Belt Company as engineering draftsman. Practically his entire business experience has been with U.G.I. interests, from May, 1903 when he started work with the company as a constructor, and for the next three years was engaged in the building of Lowe carburetted water gas plants throughout the United States. He then was sent to Johnstown, N. Y., as engineer of the Fulton County Gas & Electric Company, and in 1910 he became engineer of the Charleston Consolidated Railway & Lighting Company, Charleston, S. C. The following year he was sent to Ardmore, Pa., as acting superintendent of the Counties Gas & Electric Company. A year later he returned to Omaha as manager of the Omaha Gas Company, of which he was elected president in 1920.

Outline of Mr. Taylor's Career

In 1922 Mr. Taylor became vice-president and general manager of the Georgia Railway & Power Company, now the Georgia Power Company, Atlanta, Ga. Hydro-electric activities constitute the largest element of that company's business and the widest field for its future expansion. The company also occupies a central position in the interconnecting transmission systems of electric concerns in the South. During his period of association with the Georgia company, Mr. Taylor took a leading part in the hydro-electric and interconnecting developments. The Philadelphia Electric Power Company, a subsidiary of the Philadelphia Electric Company, now has nearing completion a hydro-electric development on the Susquehanna River, at Conowingo, Md., which is one of the foremost enterprises of its kind in the world.

Mr. Taylor was elected, Feb. 1, 1927, a vice-president of the United Gas Improvement Company, in charge of operations and maintenance. He is a member of the National Electric Light Association, American Gas Association, the American Electric Railway Association and the Philadelphia Chamber of Commerce.



William H. Taylor

Walter H. Johnson has been associated with the electric light and power industry in Philadelphia since 1887, when at the age of 24 years he became affiliated with the Edison Electric Light Company, one of the predecessor companies of the Philadelphia Electric Company. He joined the latter company in an executive capacity when it was first organized as a New Jersey corporation in 1899.

Took Part in Organizing Company

After serving as senior vice-president of the Philadelphia Electric Company for a number of years, Mr. Johnson was elected president on June 24, 1924, succeeding Mr. McCall, who became chairman of the Board of Directors.

As vice-president of he company Mr. Johnson directed the industrial side of the business, that of production and distribution, during the years when the electric light and power industry was developing rapidly in and around Philadelphia. He was largely instrumental in the organization of the Philadelphia Electric Power Company. He is a past-president of the N.E.L.A.

Second 1,200-Lb. Turbine Unit for Milwaukee

The Milwaukee Electric Railway & Light Company will soon put into operation a second turbine-generator unit designed for 1,200-lb. steam pressure. The decision to add to its existing high-pressure equipment was the result of fifteen months' operation of the first 1,200-lb. unit, during which period this unit shared the station load during a considerable portion of the time.

The new 1,200-lb. turbine will be of General Electric manufacture. The generator will be rated 7,700 kw., three-phase, 60 cycles, 13,800 volts, 90 per cent power factor. The steam conditions will be 1,200-lb. gage, 750 deg. F., and the unit will exhaust into the regular station steam mains at 300 lb. pressure.

The first unit installed by the Milwaukee Electric Railway & Light Company in 1926 was rated at 7,000 kw.

Organizes to Manufacture Bent Boiler Tubes

The American Tube Bending Company, Niles, Ohio, has been organized and incorporated to manufacture and distribute bent boiler tubes, as well as all kinds of special pipe bends, conduit couplings and all kinds of special conduit bends and goosenecks.

This concern has taken over the assets of the American Tube & Pipe Bending Company, also of Niles, Ohio.

The officers of the new corporation are A. Onorato, president, William B. Curtis, vice-president and treasurer and, J. H. Collier, secretary. I. J. Freedman will continue as general manager of the plant.

Northwest Light Plans Project on Elwha River, Wash.

The Northwest Light & Power Company, of Port Angeles, Wash., has made application to the state hydraulic office at Olympia, for appropriation of 1,200 sec. ft. of water from the Elwha River for the development of 22,000 hp. The estimated cost of the proposed project is $2,200,000.

Application is also made for reservoir rights for impounding 65,000 acre-ft., using a dam 300 ft. high and 300 ft. long on top. This will be known as the Rican Canyon project. Temporary permit has also been asked of the federal power commission.

Simplified Practice Has High Degree of Adherence

Continued growth of simplified practice as a means of eliminating waste in industry is evidenced by the completion during the calendar year 1927, of eighteen new Simplified Practice Recommendations, thus bringing the total projects completed to eighty, according to a review of the past year's activities of the Commercial Standards Group, Bureau of Standards, by Ray M. Hudson, assistant director, in charge

That simplification yields benefits sufficient to attract manufacturers, distributors and consumers alike, is demonstrated in the high degree of adherence shown by recent review of fifteen of simplified practice recommendations already promulgated. The report shows that acceptors representing an average of 82.61 per cent of the total volume of the industry effected are following the simplified practice schedules.

Further evidence that simplification is proving of great value to manufacturers and purchasers is found in the increased number of associations accepting the completed recommendations. The list of associational indorses grew from 686 to 898 during the year, the individual concerns, from 2,775 to 6,676. This means an increasing number of industrial purchasers are specifying simplified lines when buying, because they are finding that such items are usually more readily obtained; that their quality is better; and, in many instances, by reason of the savings wrought through simplification, prices are lower.

Mr. Hudson states: "Inasmuch as adherence to the adopted simplified practice recommendations has been most gratifying during 1927, with this increased percentage in acceptors, it is safe to assume that the percentage in adherence during 1928 will be much closer to 100 per cent. It must be remembered that savings from adoption of the simplified lines are obtained by the small manufacturers as well as the large, and also by the public. A survey of the benefits to acceptors from simplified practice recommendations shows many cases of definite money savings, by the small manufacturers as well as the large."

U. G. I. to Assist Erie Co.

A contract has been signed by the United Gas Improvement Company and the Erie County (Pa.) Electric Company under which U. G. I. will act as consultant and assist in the management of the Erie company, according to a recent announcement made by Arthur W. Thompson, president of the U. G. I. Company. This agreement provides for the Erie company, owned, operated and controlled by Erie County, to receive the advice and assistance of U. G. I. management in the operation of the property, which supplies steam-power generated electricity to the City of Erie and vicinity.

William L. Abbott Honored by Testimonial Dinner

On his birthday, Feb. 14, over a thousand admiring friends of William L. Abbott, chief engineer, of the Commonwealth Edison Company, crowded the ball room of the new Palmer House Hotel in Chicago to do him honor. The

William Lamont Abbott

gathering was an informal but deeply sincere tribute of respect and affection for "W.L."

During dinner, Louis A. Ferguson, toastmaster, read many letters and telegrams from friends who could not be present, and the dinner courses were interspersed with songs written for the occasion, gently poking fun at Mr. Abbott—a sure proof of genuine regard.

Col. Peter Junkersfeld spoke on Mr. Abbott's record as an engineer, outlining the pioneer work he has done, much of it before men now old in experience had entered their first school. His professional career culminated in his election to the presidency of the American Society of Mechanical Engineers in 1925.

Dr. David Kinley, president of the University of Illinois, told of his manifold services to the University, from which he graduated in 1885, and which he served for eighteen years as a member of the board of trustees, fourteen of those years as its chairman. During that period he had a large part in developing the physical plant of the university to its present splendid state.

Samuel Insull gave voice to the joy shared by all Mr. Abbott's friends over his complete recovery from the illness that laid him low two years ago, after he had completed forty years of service to the Commonwealth Edison Company.

At the close of the speeches, Mr. Ferguson presented to Mr. Abbott a silver service as a memento of the happy occasion.

Mr. Abbott responded in his characteristic witty manner, expressing his deep appreciation of the exhibition of friendship, and closed by quoting with evident emotion,

"I have you fast in my fortress
And will not let you depart
But put you down into the dungeon
In the round tower of my heart.

"And there will I keep you forever,
Yes, forever and a day,
Till the walls shall crumble to ruin
And moulder in dust away!"

Adopts Codes to Prevent Dust Explosions in Plants

Codes for the prevention of dust explosions in terminal grain elevators and flour and feed mills have just been adopted as American standards by the American Engineering Standards Committee. The preparation of the codes was sponsored by the United States Department of Agriculture and the National Fire Protection Association, which worked with a sectional committee of the American Engineering Standards Committee.

Standards were recently adopted also for pulverized fuel systems, starch factories and pulverizing systems for sugar and cocoa. Others are being studied at the present time for sulphur crushing and pulverizing, spice grinding and pulverizing, hard-rubber grinding, wood working, and the pulverization and atomization of metals.

A recent census of manufacturers showed that 28,000 plants in the United States, employing over 1,300,000 persons and with an annual production of ten billion dollars, are subject to the hazard of dust explosions. Extensive research into the causes of dust explosions by the Bureau of Chemistry of the Department of Agriculture led to a study of the problem by the National Fire Protection Association, and later to the preparation of safety codes by the American Engineering Standards Committee.

B. C. Distillery to Erect Boiler House

Selected tenders are now bidding on the boiler house to be erected for the British Columbia Distillery Company, Sapperton, B. C., according to an announcement made recently by the architects, Gardiner and Mercer, 827 Birks Building, Vancouver. The building will cost approximately $30,000 for erection alone, a large additional sum being required for the installation of equipment.

Gen. J. J. Carty and Dr. W. D. Coolidge Presented John Fritz and Edison Medals Before Distinguished Gathering

Dr. Michael I. Pupin and Bancroft Gherardi Outline Achievements of Noted Medalists

CEREMONIES of presentation of the John Fritz Medal awarded to Gen. John J. Carty last November, and the Edison Medal to Dr. William D. Coolidge in December, were held before a large gathering of the engineering profession and their friends, in the auditorium of the Engineering Societies Building, New York City, at a special meeting the evening of February 15, in connection with the annual winter convention of the American Institute of Electrical Engineers.

The program included an address by Dr. Michael I. Pupin, who outlined the achievements of Dr. Coolidge, the presentation of the Edison Medal by Bancroft Gherardi, president of the American Institute of Electrical Engineers, and the response of the medalist; the announcement of the John Fritz Medal award by J. V. W. Reynders, chairman of the board of award, an outline of the achievements of General Carty by President Gherardi, the presentation of the John Fritz Medal by Robert Ridgway, chairman of the board when the

Gen. John Joseph Carty

award was made, and the response of General Carty.

The John Fritz Medal was awarded to General Carty "for pioneer achievement in telephone engineering and in the development of scientific research in the telephone art." The award was made unanimously by a board composed of sixteen representatives of the American national societies of Civil, Mining, Mechanical, and Electrical engineers.

This honor, awarded not oftener than once a year for notable scientific or industrial achievement, is a memorial to John Fritz, late of Bethlehem, Pa., long a leader in the iron and steel industry of America.

General Carty was born in Cambridge, Mass., April 14, 1861, and

Dr. W. D. Coolidge

became interested in telephony at an early age, entered the service of the Bell Company in Boston, in 1879, and with the exception of his service in the United States army during the great war, he has been continuously with the telephone companies in various parts of the country, becoming chief engineer in 1889 of the corporation now known as the New York Telephone Company, and in 1907, chief engineer of the American Telephone & Telegraph Company, of which he is now a vice-president.

General Carty is a member of numerous engineering and scientific societies and is a past-president of the American Institute of Electrical Engineers. He has received many honors from educational institutions, scientific societies, and governments.

Some of the earlier medalists are Elmer A. Sperry, for development of the gyroscope; Edward Dean Adams, for development of hydro-electric power at Niagara Falls; John F. Stevens, for planning and organizing for the construction of the Panama Canal, building of railroads, and administration of the Chinese Eastern and Siberian Railway during and immediately after the World War; Ambrose Swasey, as a designer and manufacturer of instruments and machines of precision, a builder of telescopes, and the founder of Engineering Foundation, and Senatore Guglielmo Marconi, for invention of wireless telephony.

The Edison Medal was awarded to Dr. William D. Coolidge "for his contributions to the incandescent electric lighting and the X-ray arts." This award was made unanimously by the Edison Medal Committee, consisting of twenty-four members of the American Institute of Electrical Engineers.

Dr. Coolidge, assistant director of the research laboratory of the General Electric Company, was born in Hudson, Mass., Oct. 23, 1873. He is a graduate of the Massachusetts Institute of Technology and received his Doctor's degree at the University of Leipzig, in 1899. He was assistant professor of physico-chemical research at the Massachusetts Institute of Technology and became associated with the General Electric Company in 1905. He is a member of numerous engineering and scientific societies in the United States and abroad.

Earlier recipients of the Edison Medal, awarded annually for meritorious achievement in electrical science, engineering or arts, include Elihu Thomson, Frank J. Sprague, George Westinghouse, William Stanley, Charles F. Brush, Alexander Graham Bell, Nikola Tesla, John J. Carty, Benjamin G. Lamme, W. L. R. Emmet, Michael I. Pupin, Cummings C. Chesney, Robert A. Millikan, John W. Lieb, John W. Howell, and Harris J. Ryan.

Decides on 1,200-Lb. Pressure for New Deep Water Plant

The new Deep Water power station, to be erected on the Delaware River, near Wilmington, Del., and owned jointly by the American Gas & Electric Company and by the American Electric Power Corporation, will use 1,200 lb. pressure, according to announcement by Stevens & Wood, Inc., New York City, who have been awarded the contract for the engineering and construction of the plant soon to be underway.

Decision to use this high pressure was recently made after careful study. It is also reported that each of the two initial power turbines will be of the cross compound type, the steam being reheated in the boilers between the 12,000 kw. high pressure element and the 41,000 kw. low pressure element. The total temperature of the steam entering each of the elements will be 725 degrees.

These two 53,000-kw. power units, together with a 12,000-kw. high-pressure unit, the exhaust steam from which supplies process steam to the adjacent plant of the DuPont Company, have recently been ordered from the General Electric Company.

More Than 12,000,000 Hp. From Water in United States

The developed water power in the United States Jan. 1, was rated at 12,296,000 hp., showing an increase of 575,000 hp., or approximately 5 per cent, during 1927; and the total amount of potential water power available 90 per cent of the time is 38,110,000 hp. and that available 50 per cent of the time is 59,166,000 hp., according to an announcement by the Department of the Interior, through the Geological Survey.

The figures for potential water power are not directly comparable with the figures for developed water power, because the figures for developed power are given in terms of the capacity of the installed waterwheels, which may be several times the potential power available 90 per cent of the time. Estimates based on studies of the capacity of waterwheels installed at fully developed water-power sites indicate that about 15 per cent of the potential water power of the United States is developed at the present time. If it were feasible to develop all the water-power resources of the United States, the total capacity of waterwheels installed at all water-power plants would amount to about 85,000,000 horsepower.

All Increase to Public Utility Plants

All the increase in developed water power in 1927 was in the plants of public-utility power companies, the capacity of waterwheels in manufacturing plants showing a small decrease during the year. California still ranks first in developed water power, with a total of 1,993,000 hp. of waterwheels in water-power plants. New York, with 1,779,000 hp., is second, and Washington, with 707,000 hp., is third. The rest of the ten leading water-power states are all east of the Mississippi River.

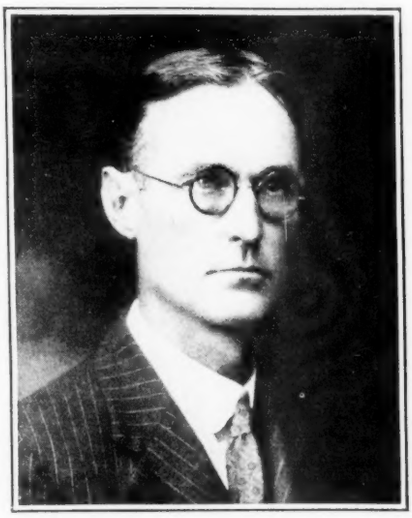
The report from which these figures are taken contains tables showing the relative importance of the divisions of the United States in developed water power, the rank of the ten leading water-power states for several years, and the total amount of developed water power in each state on Jan. 1.

The estimate of potential water power in the United States has been revised to include the results of recent studies and surveys, particularly in the upper Columbia River basin and the Tennessee River basin. Washington, with 11,200,000 hp. available 50 per cent of the time, leads all the states in water-power resources by a wide margin. It is followed by California with 6,700,000 hp., Oregon with 5,900,000 hp., and New York with 5,000,000 hp., these figures representing power available 50 per cent of the time at an efficiency of 70 per cent. Most of the undeveloped power in New York is on the Niagara and St. Lawrence rivers.

Copies of the report giving by states the developed water power on Jan. 1, and the estimated potential water power available 90 per cent of the time and 50 per cent of the time can be obtained by application to the Director, Geological Survey, Washington, D. C.

J. E. Webster Wins Post as Chief Plant Engineer

J. E. Webster has been promoted to the position of chief plant engineer of the East Pittsburgh Works of the Westinghouse Electric & Manufacturing Company, according to announcement by J. M. Hipple, works manager.



J. E. Webster

Mr. Webster took the apprentice course of the Westinghouse Electric & Manufacturing Company in 1894 and left the company at its completion for employment in New York. In 1898, he was employed as managed. of a light company in Puenta Arenes, Chile.

In 1901, he returned to the United States; and, after two years of experience in railway work, he again entered the employ of the Westinghouse company and was placed in charge of railway motor design. Mr. Webster was made director of building and equipment in 1913; and, in 1919, he became engineer of works.

Personal Mention

W. J. Bertke was re-elected president and general manager of the Sioux City, Iowa, Gas & Electric Company at the recent annual meeting in Sioux

C. M. Sides, for the last four years chief engineer of the Ozark Utilities power plant at Greenfield, Mo., has accepted a similar position at the new city plant at Lamar. He has been succeeded in his former position by Fred Champlin.

Dr. Thomas Stockham Baker, president of the Carnegie Institute of Technology, Pittsburgh, sailed for Europe Feb. 10 to complete preliminary arrangements for the Second Bituminous Coal Conference to be held in Pittsburgh Nov. 19-22.

"Chief" Isaac Krall, approaching his 85th year, an employee of the New York Edison Company, a long-time associate of Thomas A. Edison and one of the first chief engineers of the world-famous Pearl Street station, New York City, was the guest of honor of the Edison Pioneers at their tenth annual meeting and luncheon at the Hotel Astor, New York City, Feb. 11.

O. L. Taylor, mechanical engineer, formerly of the sales department, small turbine section, at the South Philadelphia Works of the Westinghouse Electric & Manufacturing Company, has been transferred to the Pittsburgh office of that company in the capacity of small turbine specialist.

William Lawrence Saunders, J. Vipond Davies and Bancroft Gherardi simultaneously completed notably long periods of continuous service at the annual meeting Jan. 26, 1928, of the board of trustees of United Engineering Society. Mr. Saunders has been a trustee for twelve years, Mr. Davies for eleven and a half, and Mr. Gherardi for nearly eight years. Each had served as vice-president, as chairman of the Finance Committee and as president.

T. M. Manley, who has served in various capacities for the Morse Chain Company for about twenty years, has recently been appointed manager of the district including the Mohawk Valley, northern New York, Vermont, western Massachusetts and northeastern Pennsylvania. Mr. Manley's headquarters are at Ithaca, N. Y. the main office and works of the Morse Chain Company.

Dr. Charles K. Edmunds, electrical engineer and an associate of the A.I.E.E., formerly provost of Johns Hopkins University, has been appointed president of Pomona College, Claremont, Calif. Doctor Edmunds was associated for twenty years with Lingnan University, formerly the Canton Christian College, Canton, China, first as a member of the faculty, later as president and finally as director of the board of trustees.

Society Affairs

American Water Works Association. The next meeting of the Canadian Section will be held at London, Ontario, Canada, March 7-9, 1928. A. U. Sanderson, Filtration Plant, Centre Island, Toronto, Ont., secretary.

AMERICAN WATER WORKS ASSOCIATION, Indiana Section meeting will be held at Purdue University, Lafayette, Ind., March 15 and 16; Cecil K. Calvert, 1902 N. New Jersey St., Indianapolis, Indiana, secretary.

Business Notes

THE ILLINOIS POWER & LIGHT CORPORATION has acquired title to all the properties of the Illinois Traction Company, Inc., used in the generation and transmission of electrical energy, including marketing equipment for electrical power sale, substations, and the Peoria, Ill., power plant.

THE MARTINDALE ELECTRIC COMPANY, 1260 West Fourth St., Cleveland, announces that it is carrying stocks of most popular sizes of commutator stones at the New York branch in charge of E. H. Mitcham, 6 East 46th St., New York City, and the Los Angeles branch in charge of John M. Dexter, 210 East Third Street.

THE WAGNER ELECTRIC CORPORATION announces the opening of a sales office at Houston, Texas, at 1006 Washington Ave. Warehouse stocks are carried at both Houston and San Antonio. W. B. Arbuckle has been placed in charge and will look after the corporation's business in that part of Texas known as South Texas, which includes Beaumont, Houston, San Antonio and south to the Rio Grande.

THE AMERICAN ELECTRIC SWITCH CORPORATION, Minerva, Ohio, announces the acquisition of the Nyelec Switchboard Company, 422 E. 53rd St., New York City. The Nyelec Switchboard Company will retain the New York office, factory and personnel and will operate as the Nyelec Division of the American Electric Switch Corporation. The sales for the present will be handled by the American Electric Switch Corporation.

Trade Catalogs

PORTABLE BLOWERS—The Martindale Electric Company, 1260 West Fourth St., Cleveland, Ohio, announce a four-page folder illustrating and describing three types of portable blowers.

ELECTRICAL SUPPLIES—Publication of the 1928-1930 catalog of electrical supplies of the Westinghouse Electric and Manufacturing Company has just been announced. This catalog presents the electrical and mechanical features and application information for all supply apparatus and appliances manufactured by the Westinghouse company, and in addition describes and illustrates a representative list of large motor and generating apparatus. All equipment obtainable through district offices or agent-jobbers is thoroughly described and illustrated. New equipment and modifications of former designs described in the new catalog are numerous and cover a wide variety of applications.

WELDING—In a booklet published by the Linde Air Products Company are set ferth the advantages resulting from the application of pipe welding to plumbing and heating systems. It is well illustrated with pictures of welded heating systems and with diagrams showing methods of making various kinds of joints.

HEAT RECOVERY FROM COKE — Dry Quenching Equipment Corporation, 200 Madison Avenue, New York City, a subsidiary of International Combustion Engineering Corporation, has issued catalog DQ-2, describing the Sulzer System for the dry quenching of coke, with heat recovery by means of waste heat boilers. This system, developed by Sulzer Bros., Winterthur, Switzerland, is controlled in the United States by Dry Quenching Equipment Corporation. The system has been widely adopted in Europe and has been installed at the Rochester Gas & Electric Corporation, Rochester, N. Y. The catalog, which is splendidly illustrated and printed, describes the process, its applications, and shows how the net annual return from steam generated in this manner at a 1,000-ton coke plant would be about $170,000.

Coming Conventions

American Institute of Electrical Engineers, St. Louis Regional Meeting, District No. 7, March 7-9; Baltimore Regional Meeting, District No. 2, April 17-19; New Haven Regional Meeting, Northeastern District, No. 1, in May; Summer Convention, in Denver, June 25-29.

American Institute of Refrigeration, Washington, D. C., May 10-11.

American Society of Mechanical Engineers, spring meeting in Pittsburgh, May 14-17; Calvin Rice, secretary, 29 West 39th St., New York City.

American Society for Testing Materials, Atlantic City, June 25-29.

American Water Works Association. Annual meeting, Hotel Fairmont, San Francisco, June 11-16; W. M. Niesley, 170 Broadway, New York City.

Association of Iron and Steel Electrical Engineers, annual convention and Iron and Steel Exposition at Hotel Stevens, Chicago, June 25-29.

National Association of Power Engineers, annual convention at Detroit, Sept. 11-15, and concurrently National Exhibitors' Assn. exhibit; Fred Raven, 417 South Dearborn St., Chicago.

National Board of Boiler and Pressure Vessel Inspectors, meeting at Erie, Pa., June 18-20.

National Electric Light Association, Convention and exhibition, Atlantic City, N. J., June 4-8; A. Jackson Marshall, secretary, 420 Lexington Ave., New York City.

National District Heating Association, annual meeting at Ambassador Hotel, Atlantic City, June 12-15; D. J. Gaskill, sec., 112 West 4th St., Greenville, Ohio.

Stoker Manufacturers Association, fall meeting at Greenbrier Hotel, White Sulphur Springs, W. Va., Oct. 22-24.

Universal Craftsmen Council of Engineers, Newark, N. J., Aug. 7-10.

Second Bituminous Coal Conference will be held at Pittsburgh, Nov. 19-22.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	
Navy Standard	New York	$2.50@$2.65
Kanawha	Columbus	1.25@ 1.60
Smokeless	Cincinnati	2.00@ 2.25
Smokeless	Chicago	1.85@ 2.25
S. E. Kentucky	Chicago	1.40@ 1.60
Steam	Pittsburgh	1.75@ 1.85
Gas Slack	Pittsburgh	1.00@ 1.25
Big Seam	Birmingham	1.50@ 2.00
Anthracite (Gross Tons)		
Buckwheat	New York	$3.00@$3.25
Birdseye	New York	1.60

FUEL OIL

New York—Feb. 16, light oil tank-car lots, 28@34 deg. Baumé, 4¾@5c. per gal.; 36@40 deg., 5¾@6c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Feb. 7, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.55 per bbl.; 26@28 deg., $1.60 per bbl.; 28@30 deg., $1.65 per bbl.; 30@32 deg., $1.70 per bbl.; 32@36 deg., gas oil, 4.3c. per gal.; 38@40 deg., 5½c. per gal.

Pittsburg—Jan. 12, f.o.b. local refinery, 30@34 deg., fuel oil, 4½c. per gal.; 36@40 deg., 4¾c. per gal.

Philadelphia — Feb. 15, 26@30 deg., $2.00@$2.06 per bbl.; 13@19 deg., $1.26 @$1.32 per bbl.; 22 plus, $1.58@$1.64 per bbl.; 27@30 deg., $2.10@$2.16 per bbl.

Cincinnati—Feb. 13, tank-car lots f.o.b. local refinery, 24@26 deg. Baumé, 4.9c. per gal.; 26@30 deg., 5.15c. per gal.; 30@32 deg., 5½c. per gal.

Chicago—Feb. 11, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl.; 22@26 deg., 80@85c. per bbl.; 26@30 deg., 90c. per bbl.; 30@32 deg., $1.05@$1.10 per bbl.

Boston—Feb. 13, tank-car lots, f.o.b 12@14 deg. Baumé, 4¼c. per gal.; 28@ 32 deg., 5¾c. per gal.

Dallas—Feb. 10, f.o.b. local refinery, 26@30 deg., $1.40 per bbl.

NEW PLANT CONSTRUCTION

Ala., Decatur—Mason Brown, c/o Brown Ice Co., Birmingham, plans the construction of an ice plant on First St. Estimated cost $65,000.

Ark., Camden—Camden Ice & Coal Co., R. S. Martin, Pres., is having preliminary sketches made for a 30 ton ice plant. Estimated cost $50,000.

Calif., Long Beach—Motor Transit Co., 24 Locust St., plans the construction of a stage depot and hotel. Estimated cost $1,000,000. Architect not selected.

Calif., Redwood City—San Mateo County, plans the construction of a pumping plant in connection with sewage treatment plant at Millbrae Villa tract. G. A. Kneese, Courthouse, Redwood City, is engineer.

Calif., San Bernardino—City plans waterworks improvements including wells, pumping plants, etc. Estimated cost $40,000.

Calif., Watsonville—Coast Counties Gas & Electric Co., 175 Pacific Ave., Santa Cruz, plans the construction of a sub-station here. Estimated cost including equipment $30,000.

Conn., Mintville—Robert Gair Co., is receiving bids for the construction of a boiler house. Estimated cost including equipment $40,000.

Conn., Windsor Locks — Northern Connecticut Power Co., W. P. Schwabe, Pres., Thompsonville, is having preliminary plans prepared for 50,000 hp. hydro electric power plant here. Estimated cost $2,000,000. J. G. White Engineering Cor., 43 Exchange Pl., New York, N. Y., is engineer.

Ill., Chicago—Chicago Motor Club, 3254 South Michigan Ave., is having plans prepared for a 12 story club building at Garland Ct. and East South St. Estimated cost $1,000,000. Holabird & Roche, 104 South Michigan Ave., are architects.

Ill., Chicago—A. M. Johnson, 77 West Washington St., will receive bids about Mar. 1 for the construction of an apartment building including electric refrigeration system, etc., at 4830 Drexel Blvd. Estimated cost $1,000,000. Private plans.

Ill., Chicago—E. M. Willoughby, 77 West Washington St., awarded general contract for a 36 story office and stores building at Madison St. and South Michigan Ave. to Dilks Construction Co., 160 North La Salle St. Estimated cost $2,500,000.

Ind., Bloomington — Bloomington Hotel Co., is having plans prepared for an 8 story hotel including elevators, etc. Estimated cost $600,000. Ross Caldwell, 620 Continental Bank Bldg., Indianapolis, is architect.

Ind., Indianapolis — Methodist Hospital, 16th and Capitol Sts., will build a 7 story hospital including elevators, etc. Estimated cost $500,000. D. A. Bohlen & Son, 1001 Majestic Bldg., are architects. Work will be done by separate contracts.

Maryland—The Industrial Fibre Co., H. Rivitz, Pres., West 98th St. and Walford Ave., Cleveland, O., is having plans prepared for the construction of a factory and power plant, here. Estimated cost $1,000,000. J. E. Sirrine Co., 309 South Main St., Greenville, S C.., is architect and engineer.

Md., Baltimore—Glen L. Martin Co., 16800 St. Clair St., Cleveland, O., plans the construction of first unit of airplane factory here. Estimated cost $1,500,000.

Mass., Boston—Atlantic Building Trust, c/o M. C. Burton, 470 Atlantic Ave., will receive bids about Feb. 21 for a 13 story office and manufacturing building including power and lighting plant at Atlantic Ave. and Pearl St. Ext. Estimated cost $3,000,000 to $4,000,000. Blackall, Clapp & Whittemore, 31 West St., are architects.

Mass., Cambridge (Boston P. O.) — Harvard University Athletic Assn., W. J. Bingham, Dir., 399 Harvard St., is having plans prepared for a gymnasium including two swimming pools, etc., at Winthrop, Holyoke and Dunster Sts. Estimated cost $1,225,000. Coolidge, Shepley & Bulfinch & Abbot, Ames Bldg., Boston, are architects.

Mass., Fall River—Fall River Real Estate Association, F. S. Stevens, Swansea, plans to rebuild store and office building at South Main, Central and Pocasset Sts., recently destroyed by fire. Estimated cost $1,200,000. Architect not selected.

Mass., Fall River—Mohican Hotel, W. Durfee, North Main St., plans the construction of a hotel at North Main and Central Sts. Estimated cost $1,000,000. The Stevens Co., 522 Fifth Ave., New York, N. Y., is architect.

Mass., Lynn—North Shore Ice Co., A. W. Thomas, Pres., 46 Lake St., is having sketches made for the construction of an ice and cold storage plant on Boston St. Estimated cost $150,000 to $200,000 Funk & Wilcox, 26 Pemberton Sq., Boston, are architects. York Ice Machinery Corp., 200 Causeway St., Boston, is engineer.

Mass., Roxbury (Boston P. O.)—New England Baptist Corp., A. H. Curtis, Pres., Parker Hill Ave., is having sketches made for a 6 or 7 story addition to hospital. Estimated cost $500,000. Kendall, Taylor & Co., 142 Berkley St., Boston, are architects.

Mich., Detroit—University of Detroit is having plans prepared for the construction of a group of college buildings including detached central heating plant at Six Mile Rd. and Livernois Ave. Malcolmson & Higginbotham, 1217 Griswold St., are architects.

Mo., Clayton—St. Louis County, c/o A. Wehmeyer, Judge, will soon receive bids for first unit of hospital including steam heating system, etc. Estimated cost $300,000. Total cost $1,000,000.

Mo., Joplin—Allis Hotel Co., B. L. Allis, Pres., awarded contract for a 9 story addition to hotel at Fourth and Joplin Sts. to C. A. Dieter Construction Co., 202 Independent Bldg. Estimated cost $600,000.

Mo., Marshall—City defeated bond election of Jan. 31 for $80,000 bonds for extensions and improvements to municipal light plant. Henrici-Lowry Engineering Co., 401 Security Bldg., Kansas City, is engineer.

Mo., St. Louis—Owner, c/o Pleitsch & Price, Arcade Bldg., Archts., is having preliminary plans prepared for a 15 story apartment including steam heating system, etc. on Lindell St.

Mo., St. Louis—C. Ulman, Paul Brown Bldg., will soon receive bids for two 10 story apartment buildings including steam heating system, etc. at Maryland and York Aves. Total estimated cost $3,000,000. P. J. Bradshaw, International Life Bldg., is architect.

Mo., University City—Syndicate, c/o H. R. Weisels Co. Inc., 730 Chestnut St., St. Louis, will soon receive bids for a 6 story office and apartment building including steam heating system, etc. at Delmar, Hetman and Syracuse Sts. here. Estimated cost $900,000. P. J. Bradshaw, International Life Bldg., St. Louis, is architect.

Neb., Lincoln—State Building Comn., G. McMullen, Chn., awarded contract for the construction of a state capitol building to Peter Kiewitz Sons Co., 908 Omaha National Bank Bldg., Omaha. Estimated cost $1,049,000.

N. J., Camden—Camden Rail & Harbor Terminal Corp., F. Cohen, Front St., awarded contract for the construction of a cold storage plant at Front St. and Kaighn Ave. to Cramp & Co., Dencker Bldg., Philadelphia, Pa. Estimated cost $750,000.

N. J., Deal—Coast Holding Co., I. Marshall, Pres., 309 Bond St., Asbury Park, plans the construction of two 12 or 14 story apartment buildings including steam heating system, etc. at Deal Lake Dr. Kingsley, Ocean and Eighth Sts. Estimated cost $2,000,000. Private plans.

N. J., Newark—Twenty Six-Thirty Two Johnson Ave. Inc., c/o H. F. Clark, 38 Clinton St., Archt., is having sketches made for a 10 story apartment building including steam heating system, etc. Estimated cost $500,000.

N. J., Orange—Aetna Realty Co., H. H. Levy & L. E. Lehman, 31 Wayne Ave., East Orange, plans the construction of a 6 story medical office building including steam heating system, etc. here. Estimated cost $1,000,000. Architect not announced.

N. J., Pitman—Riley Milk & Ice Cold Storage Co., awarded contract for a cold storage plant to A. Denny. Estimated cost $100,000.

N. J., Roebling—J. A. Roebling's Sons Co., W. A. Anderson, Treas., South Broad and Canal Sts., Trenton, plans the construction of a rod mill here. Estimated cost $1,000,000. Architect not selected.

N. Y., New York—Broadway Improvement Corp., 30 Pine St., awarded contract for a 20 story office building at Broadway and 14th St., to G. R. Davis, 10 East 41st St. Estimated cost $700,000.

N. Y., New York—F. E. Campbell, 1790 Broadway, is having plans prepared for an 11 story funeral chapel and office building at Madison Ave. and 82nd St. Estimated cost $1,000,000. F. S. Parker, 119 West 57th St., is architect.

N. Y., New York—Fur Merchants Cold Storage Co., D. Nichelsburg, is having preliminary plans prepared for a 10 story addition to cold storage plant. Estimated cost $300,000. B. Gunlach, 110 East 42nd St.,

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is architect. Ophuls & Hill, 112 West 42nd St., are engineers.

N. Y., New York—Gerry Estates, Inc., 238 Broadway, had plans prepared for a 33 story addition to hotel at 761 5th Ave. Estimated cost $3,000,000. McKim, Mead & White, 101 Park Ave., are architects.

N. Y., New York—International Benjamin Franklin Society, W. Guggenheim, Chn., 35 East 50th St., plans the construction of an office and memorial building. Estimated cost $15,000,000 to $18,000,000. F. B. Huntington, 420 Lexington Ave., and Turner & Bowden, 19 West 44th St., are associate architects.

N. Y., New York—News Syndicate Inc., 25 Park Pl., is having plans prepared for a 20 story newspaper and office building at 216 East 42nd St. Estimated cost $6,000,000. J. M. Howells, 40 West 40th St., is architect. Lockwood, Greene & Co., 1

N. Y., New York—New York Hotel Corp., c/o Jonas & Neuberger, 11 Broadway, awarded contract for a 36 story hotel at 8th Ave. and 34th to 35th St., to M. Kanner and J. Becker, 145 West 57th St. Estimated cost $20,000,000.

N. Y., New York—New York Trust Co., 277 Madison Ave., had plans prepared for an 18 story bank and office building. Estimated cost $700,000. J. E. R. Carpenter, 598 Madison Ave., is architect.

N. Y., New York—W. H. Reynolds, Pres., Reylex Corp., 405 Lexington Ave., plans the construction of a 60 story office and stores building, including elevators, etc., at Lexington Ave. between 42nd and 43rd Sts. Estimated cost $12,000,000. W. Van Alen, 331 Madison Ave., is architect.

N. Y., New York—Syndicate, c/o F. B. Hoffman, Jr., 147 East 51st St., Archt., is having sketches made for a 14 story apartment building at 71st and 72nd Sts. E. of 5th Ave. Estimated cost $4,000,000. Work will be done by separate contracts.

N. Y., New York—Three Hundred Seventy Lexington Ave. Corp., F. W. Woodward, Pres., 347 Madison Ave., awarded contract for a 30 story hotel to Shroder & Koppel, 420 Lexington Ave. Estimated cost $3,000,000.

N. Y., New York—Realty Managers, Inc., F. Begrisch, Pres., 342 Madison Ave., plans the construction of an office building at Sixth Ave. and 50th St. Estimated cost $500,000.

O., Cincinnati—Ninth St. Garage Co., 34 West 6th St., will soon award contract for an 8 story garage at Ninth and Walnut Sts. Estimated cost $1,000,000. Tietig & Lee, 34 West 6th St., are architects.

O., Cleveland—Cleveland Electric Illuminating Co., Illuminating Bldg., awarded contract for addition to power plant to Hunken-Conkey Construction Co., Hunkin-Conkey Bldg. Estimated cost $50,000.

O., Cleveland—The Grasselli Chemical Co., Guardian Bldg., had plans prepared for a burner building and power plant on Independence Rd. Estimated cost $40,000. Private plans.

O., Youngstown—Central Savings & Loan Co., 1 West Federal St., will soon receive bids for a 13 to 15 story bank and office building at Central Sq. and West Federal St. Estimated cost $850,000 to $1,000,000. M. Schabel, Youngstown, and Roland Johnson, Cleveland, are associate architects.

Okla., Shawnee—E. A. Liebman & Son, 3509 Classen St., Oklahoma City, is having preliminary plans prepared for a 35 ton raw water ice plant, here. Estimated cost $70,000. Private plans.

Okla., Talihina—Talihina Ice Co., is having preliminary plans prepared for a new 10 ton raw water ice plant. Estimated cost $30,000. Private plans.

Pa., Altoona—Bd. of Education has retained H. O. Swoboda Inc., 3400 Forbes St., Pittsburgh, Engrs., for increasing capacity of central light, heat and power plant.

Pa., Philadelphia—Maker City Cold Storage Co. will soon award contract for the construction of a cold storage plant at 314 South Delaware St. Ballniger Co., 12th and Chestnut Sts., is architect.

Pa., Philadelphia—S. M. Green Co. and A. H. Lavalle, Springfield, Mass., Archts., will receive bids until Feb. 23 for a 23 story bank and office building at 16th and Walnut Sts. for Peyton Realty Co., c/o Integrity Trust Co., 717 Chestnut St. Estimated cost $2,250,000. Albright & Mebus, 1521 Locust St., are engineers.

Pa., Pittsburgh—Ambassador Apartment Corp., c/o Marks & Kann, Home Trust Bldg., awarded contract for an 8 story apartment building on Center Ave. to H. Rubenstein, 329 2nd Ave. Estimated cost $500,000.

Tenn., Nashville—Peter Fox Sons Co., F. G. Fox, Pres., 1122 Fulton Market, Chicago, Ill., plans the construction of an ice and cold storage plant on Monroe St., here. Estimated cost $500,000.

Tex., Big Lake—M. Moore, Mayor, will soon award contract for waterworks improvements including well, reservoir, pumps, etc. Estimated cost $35,000. Devlin Engineering Co., 127 Central Bldg., Amarillo, is engineer.

Tex., Corpus Christi—Planters & Shippers Compress Co., awarded contract for a cotton compress and storage plant to A. S. Bergendahl. Estimated cost $1,250,000.

Tex., Florence—City voted $30,000 bonds for improvements to waterworks and distribution systems including pumping plant, etc. Private plans.

Tex., Hidalgo—Hidalgo Utilities Co., c/o A. Y. Baker, plans improvements to waterworks probably including pumping equipment, mains, etc. Estimated cost $35,000. Private plans.

Va., East Radford—G. S. Powe has made application to the Federal Power Commission for permit to construct a hydro-electric power plant, 12,000 hp. capacity on the New River. Plans include a dam 50 ft. and reservoir, 12 mi. long.

Va., Martinsville — Community Electric Co. is considering plans for rebuilding power house in Henry county recently destroyed by fire.

Wash., Seattle—O. H. Bailey & Associates, 45th and University Way, is having plans prepared for a 12 story office building. Estimated cost $500,000. J. A. Creutzer, Medical and Dental Bldg., is architect.

Wash., Seattle — A. B. Engle & Associates, representing Tom C. Taylor Co., 550 Pelmont St., Portland, Ore., will build a pulp and paper mill, here. Estimated cost $2,500,000 and $3,000,000.

Wash., Seattle—Malloy Apartments, 15th Ave. and East 45th St., will soon award contract for the construction of an 8 story apartment building. Estimated cost $650,000.

Wis., Beloit—United Studios, Inc., 14 West Lake St., Chicago, Ill., is having plans prepared for a 7 story hotel and theatre building on Public Ave., he also an 11 story hotel and theatre at F. h and Virginia Sts., Joplin, Mo. Estimated cost $525,000 and $750,000 respectively.

Wis., North Milwaukee—Common Council will soon award contract for a complete ornamental street lighting installation, including sub-station. H. C. Webster, 216 West Water St., Milwaukee, is engineer.

Ont., Toronto—Canada Permanent Mortgage Corp., 14 Toronto St., plans the construction of a 16 story office building including steam heating system, elevators, etc. at Bay and Adelaide Sts. Estimated cost $1,000,000. Architect not selected.

Sask., Saskatoon—Mid West Utilities Co. Ltd., C. J. Torath, Pres., is negotiating with the city for a franchise to construct a power plant. Estimated cost $1,500,000. E. W. Bowness, C. P. R. Bldg., Edmonton, Alta., is engineer.

Equipment Wanted

Air Compressors, Etc.—D. C. Commissioners, Washington, D. C., will receive bids until Feb. 23 for four air compressors, etc. for use in highway department, also until Feb. 28 for furnishing and installing and connecting to air receiver one horizontal centrifugal motor driven air compressor complete.

Boilers, Stokers, Generators, Engines, Refrigeration Apparatus, etc.—Borden Farm Products Co., Inc., 110 Hudson St., New York, N. Y., plans to purchase electrically driven machinery including three 175 hp. boilers equipped with stokers, 400 kw. generators connected with steam engines, refrigeration apparatus, etc., for proposed plant at Macon, Miss.

Electrical Equipment—City of Glendale, Calif., A. J., Van Wie, Clk., will soon receive bids for electrical equipment including four three pole, single throw, 2000 amp., 7500 v. oil circuit breakers, electrically operated, remote control, non-automatic; fifteen 3 pole, single throw, 600 amp., 7500 v. oil circuit breakers, capable of interrupting 11,000 amp., 4150 v. electrically operated, remote control, full automatic with trip free relay; fifteen 250 amp., 3 ph., 50 cycle reactors, to give approximately 3% reactive drop when connected in series in a 1440 kva., 3 ph. 4150 v. circuit; fifteen 500 amp., 3 ph. 60 cycle reactors, to give approximately 3% reactive drop when connected in series in a 2875 kva. 3 ph., 4150 v. circuit; alt. bids will be received on above reactors having shunt resisters; thirty-three 3000 amp., 7500 v. single pole, single throw disconnect switches and six 600 amp. 6000 v. single pole, single throw disconnect switches.

Engine and Generating Units—Dept. of Welfare, J. E. Harper, Dir., Ninth and Oak Sts., Columbus, O., will receive bids until March 5 for a 250 hp. engine and generating unit for Institution for Feeble Minded at Orient, O., also a 200 hp. engine and generating unit at Ohio Penitentiary, Columbus, O.

Generating Units, Hoist, etc. — E. J. Bestick, Clk., Detroit, Lakes, Minn., will receive bids until Mar. 5, for one 500 and one 625 kva. engine generating units, also for electric driven ash hoist, 1 ton capacity, for municipal light and power plant.

Motor Control Equipment — G. Gross, County Clk., Oakland, Calif., will readvertise for bids for motor control equipment for ventilating fans for Oakland-Alameda Estuary tube. Former bids rejected.

Pump—Newport Mesa Irrigation Dist., D. J. Dodge, Secy., Costa Mesa, Calif., will receive bids until Feb. 21 for furnishing and installing a turbine pump in well in Santa Ana river valley.

Pumping Unit—Town Engineer, Municipal Bldg., Bloomfield Ave. and Valley Rd., Montclair, N. J., will receive bids until Mar. 6, for one 4,000,000 g.p.d. electric motor driven centrifugal pumping unit for Watchung water pumping station.

Pumping Units, Etc.—City of Brunswick, Ga., will receive bids until Feb. 20 for two centrifugal pumping units, etc. for proposed sewage treatment works.

Pump, Motor, etc. — Louisville Gas & Electric Co., 435 South 3rd St., Louisville, Ky., plans the installation of a 60,000,000 g.p.m. centrifugal pump direct connected to electric motor in River Station of Louisville Water Co. for pumping water to reservoir. Estimated cost $75,000.

Pumps, Etc.—City of Lockwood, Mo., will receive bids until Feb. 29 for a 100 g.p.m. deep well pump with 25 hp. motor, one 350 g.p.m. centrifugal pump, etc., for proposed waterworks improvements. Estimated cost $55,000.

Pumping Equipment—Texas Water Co., Cameron, Tex., will soon receive bids for pumping equipment, etc. for proposed waterworks improvements.

Pumps, Motors, Transformers, Lightning Arresters, etc.—West Stanislaus Irrigation Dist., Patterson, Calif., plans to purchase pumps, 45 cu.sec. capacity, 32 units, $88,000, 32 150 hp. motors and control, $81,920, pump station and sub-station transformers, $57,500, lightning arresters $570, etc., for proposed irrigation work.

Transformers — Bd. of Purchase, H. C. Cain, Secy., City Hall, Columbus, O., will receive bids until Mar. 1, for four 15, four 25, four 37½ and four 50 kva., 2300-230/115 v. o.i.s.c. transformers, also four 15, four 25, four 37½ and two 50 kva., 6900-230/115 v. o.i.s.c. transformers for electric light plant.

Transformers, Meters, Etc.—Coast Counties Gas & Electric Co., 175 Pacific Ave., Santa Cruz, Calif., plans to purchase transformers, meters, etc. for proposed electrical lines in Santa Cruz, Santa Clara and San Benito Counties. Estimated cost $275,000.

Turbine, Generator, Transformers, etc.—City of Eugene, Ore., will receive bids until Mar. 15 for one 9,000 hp. vertical shaft hydraulic turbine, one 7,500 kva. vertical shaft synchronous a.c. generator, six 2,500 kva. single phase stationary a.c. transformers, one 75 kw. 250 v. motor driven exciter, etc., for water and municipal power system. Estimated cost $2,250,000.